THE CEREBRO-SPINAL FLUID

ITS SPONTANEOUS ESCAPE FROM THE NOSE

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Terence Cawthorne, F.R.C.S

with the kind regards
best wishes of the author.

St Clair Thomson.
1938.

THE CEREBRO-SPINAL FLUID;

ITS SPONTANEOUS ESCAPE FROM THE NOSE.

WITH OBSERVATIONS ON ITS COMPOSITION AND FUNCTION IN THE HUMAN SUBJECT.

BY

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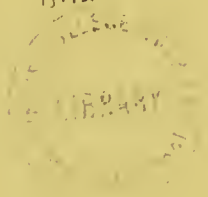

PREFACE.

Two and a half years ago I discovered that a young woman in apparently good health, and without any tangible cause, was suffering from the escape of cerebro-spinal fluid from one side of the nose. This produced no other symptom than the mechanical one of inconvenience. The flow was at first intermittent in its appearance, but for more than three years it has been continuous both day and night,—with only four intermissions, one of these lasting for sixteen days, two lasting for twenty-eight days, and the other for two months. To all intents and purposes the patient remains in perfect health; indeed, as regards attacks of headache to which she had been subject, she is even better than she was before this flow commenced.

An attempt to establish a hitherto unrecognised pathological possibility on the observation of a single case might be met with the objection which occurs in French law, *Testis unus, testis nullus.* But a prolonged and extensive search through medical literature has convinced me that, while the condition is probably one of extreme rarity, still similar cases have already been published, although in the majority of instances the exact source of the fluid which escaped from the nose was overlooked, and the discharge was ascribed to hypersecretion from the mucous membrane. I have, however, succeeded in collecting the records of twenty other cases, and their study is made the more interesting by the fact that most of them were asso-

ciated with cerebral symptoms and some with retinal changes.

In this way the recognition of a single case of cerebro-spinal rhinorrhœa has led to the collection and consideration of others occurring in literature, and has enabled me to give a description of a condition which will help to the discovery of other cases, and to a more complete study of the subject.

The patient in whom this curious phenomenon occurred attended the clinic of my colleague Dr. J. W. Bond, to whom I have to express my great indebtedness for kindly permitting me to make full observations on the case. Apart from the clinical aspect of the condition, the unique opportunity was afforded for making a series of observations on the composition and function of the cerebro-spinal fluid in the human subject.

These have already been published in vol. lxiv of the 'Proceedings of the Royal Society' in a conjoint paper by Professor Halliburton, Dr. Leonard Hill, and myself, and the conclusions arrived at have been incorporated in the following pages. I have to thank Professor Halliburton most cordially for freely placing at my disposal not only his very special knowledge of the physiological chemistry of cerebro-spinal fluid, but also his valuable time in repeatedly making most thorough analyses of the various samples of fluid I have submitted to him.

StCLAIR THOMSON.

28, Queen Anne Street, W.;
April, 1899.

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IN TWENTY-ONE INSTANCES.

THE CEREBRO-SPINAL FLUID;

ITS SPONTANEOUS ESCAPE FROM THE NOSE.

Historical.

A reference to Landois and Stirling's 'Text-book of Human Physiology,' published in 1885, shows how little was known at that date of the cerebro-spinal fluid, the only notice of it being a quotation from Hoppe-Seyler. Indeed it is remarkable that, until the recent work of Halliburton,[1] little has been added to our knowledge of this liquid since 1842, when Magendie published his 'Recherches sur le Liquide Céphalo-Rachidien,' in order, as he writes, to place beyond doubt the normal existence of this fluid. Previous to that date knowledge of the secretion in question had been very confused and unsatisfactory. Galen repeatedly speaks of an excrementitial liquid, expressed from several points of the brain into the ventricles, especially into the fourth, where it is stored, and then purged into the nose through the ethmoid bones and infundibulum. It is here curious to note that although Galen was of course mistaken in thinking that this was a physiological procedure, yet I hope to show the possibility of such a route as he imagined. It is difficult to say if Galen's opinions were the result of direct observation, or if they were merely speculative. After his period, Massa, Vesalius, Vidus-Vidius, and Varoli refer to a watery humour in the brain. In the

[1] 'Chemical Physiology and Pathology,' London, 1891, p. 355.

sixteenth century we find Sansovino [1] still calling the nasal cavity the "cloaca del cerebro." Schneider [2] finally showed how baseless was the fabric of the anatomical vision which saw any free communication between the nose and the ventricles of the brain.

It was not till the time of our own Willis [3] that the method of direct observation was brought to bear on the question as to what became of the cerebro-spinal fluid, a question which appears to have considerably puzzled the elder anatomists. Willis acknowledges that it is at first sight difficult to see how this fluid passes off through the holes in the cribriform plate, since they are completely blocked during life by the nerve fibres and the prolongations of the dura mater. Yet he holds that it is permissible to think that the fluid descends into the nose by openings which are invisible after death, but dilatable during life "by heat and the spirit." But Vieussens [4] points out that the pituitary membrane cannot be the excretory surface for the aqueous humour of the brain. He had opened many crania and found a quantity of water in individuals who had never during life voided anything similar by the nose or mouth. The following experiments confirm this view:—He poured alcohol into the anterior fossa of the skull and left it there some time; not a drop escaped from the nose, not even when the dura mater was stripped off the ethmoid. Besides, if a living animal is taken, and the two carotids and jugulars ligatured, and coloured alcohol is then injected into the carotids until all the vessels are distended, he found that the cavities of the brain will be flooded, but that nothing will escape from the nose.

Cotugno (1736–1822),[5] who gave his name to the

[1] F. Sansovino, 'L' edificio del corpo umano,' Venet., 1550 (ref. in Zuckerkandl).

[2] 'Liber de osse cribriformi,' &c., and 'De catharris,' Wittenbergæ, 1655.

[3] 'Opera Omnia,' Geneva, 1695, "Anatom. Cerebri," chaps. xi, xii, and xiii.

[4] 'De natura et necessitate spiritus animalis et de succo nervoso.'

[5] 'De Ischiade Nervosa,' Neapoli, 1764, in Sandifort's 'Thesaurus Dissertationum,' Roterodami, 1769.

Liquor Cotunnii, calculates the amount in the cadaver at about four to five ounces; but although he had found the fluid in living fish and turtles, he is sceptical as to its existence in the living human subject.

It is interesting to note that the work of Willis, Vieussens, and Cotugno, must have been strangely overlooked for it to be necessary for Magendie to, so to speak, rediscover this fluid. The fact is another confirmation of the saying that nothing is new except what has been forgotten.

Escape of Cerebro-spinal Fluid from the Cranium.

A. *From the Ear, after Injury.*

That the cerebro-spinal fluid can escape from the cranium in cases of injury has been known for some time. As early as the year 1727 Stalpartius van der Wiel ('Observat rarior. cent. prior.,' Obs. xv),[1] published a case in which large quantities of a thin, clear, watery fluid had escaped from the ear for several days after a severe injury to the head. O'Halloran and Dease published cases, but these appear to have been lost sight of until Laugier called attention to the co-existence of a watery discharge and rupture of the membrana tympani in some cases of fracture of the base.[2] The character of the fluid was not recognised at first, but it was established by Nélaton, Robert, Rabourdin, Chatin, and Deschamps.[3] Guthrie[4] held that the fluid probably came from the cavity of the arachnoid, and pointed out that it was symptomatic of great danger. This accident is now, of course, a matter of common observation.

[1] Quoted in Holmes' 'System of Surgery,' 3rd edit., vol. i, 1883, p. 592.

[2] 'Comp. Rend. de l'Acad. des Sci.,' 1839, p. 240.

[3] 'Bulletin de l'Acad. de Méd.,' xviii, 7 déc., 1852, p. 240.

[4] "On Injuries of the Head affecting the Brain," 'Med.-Chir. Review,' No. 76, 1841, p. 302.

B. *From the Ear, spontaneously.*

The possibility of cerebro-spinal fluid escaping spontaneously from the ear had not entered my mind when I first commenced to interest myself in this subject, and it was only during the preparation of this paper that I met with the record of a case published by Escat (of Toulouse).[1]

His patient was a girl aged 10, who eighteen months previously had first noticed the escape of a clear watery fluid from the right ear. The flow was intermitting, it lasted a few minutes, then stopped abruptly, but recurred ten or twelve times in the day. This state of things lasted two months, and then ceased suddenly under no special treatment. A year later the same phenomenon reappeared, and lasted about a month. Finally the flow again appeared eight days before the patient was brought for advice on the 8th May, 1897. There was no previous history of consequence, no ear trouble, no introduction of foreign body, and no history of accident. The flow came on without apparent cause. A few seconds before it appeared there was a whistling in the right ear, which ceased as soon as the liquid began to flow. At each escape about half a tumbler of liquid was lost, and the total quantity in twenty-four hours was calculated at half a litre. The flow continued during the night, and in the daytime the patient was obliged to wear over the right ear a large linen compress, which required frequent renewal. The flow was generally more abundant during the three hours after meals, and the patient noticed that she could increase it by straining. During one flowing 150 grammes were easily collected, and submitted to Professor Gérard, who reported as follows:

"The liquid is undoubtedly cerebro-spinal fluid, as the following analysis shows:

"Colourless liquid, limpid, faintly alkaline, very slight turbidity with heat in presence of acetic acid.

"Chloride of sodium . . .	6·3 gr. per litre.
Earthy phosphates (or PH_2O_5) .	0·4 „ „

Traces of cholesterin and albumin."

In spite of this flow the patient's general health was satisfactory. She complained of no pain or malaise, and although her parents noticed some lassitude and intellectual torpor during the flow, this was not marked, and she continued her work and play at school as formerly.

[1] 'Archiv. Internat. de Laryngologie,' tome x, No. 6, 1897.

Direct examination of the right ear showed that the tympanic membrane, including Shrapnell's membrane, was quite intact, and the Eustachian catheter indicated that the middle ear was free of liquid. The external two thirds of the auditory meatus showed nothing abnormal; but in the inner third, on the upper wall, a fine white line was detected. This did not disappear after cleansing; and although suction with Siegle's speculum failed to draw any liquid from it, and a fine probe could not detect any corresponding crack or depression, yet Escat decided that this spot indicated the point of escape of the fluid from the cranial cavity. He applied the galvano-cautery to it, and the flow ceased and had not recurred two months later.

In his conclusions from this case the author excluded traumatism or any ulcerative process. He regarded it as due to a congenital defect, or at least predisposed to by a congenital atrophy of the upper wall of the external auditory meatus, which became more marked in the course of the development of the temporal bone and ended in a genuine partial absorption of the floor of the temporal fossa.

When compared with the cases I have been able to collect there can be little doubt that this was indeed an instance of spontaneous escape of cerebro-spinal fluid from the external auditory meatus. Although the analysis does not give the specific gravity, nor mentions the substance which reduces Fehling's solution, it is yet sufficiently complete to exclude the question of its being other than arachnoid fluid.

I am inclined to ask for some reserve in attributing a cure to the sealing of the cuticular opening with the cautery. If the bone is really defective it is likely that the fluid will break its way through the cicatrix whenever the pressure becomes increased. For we must note that the flow had on two previous occasions ceased spontaneously, once for a whole year.

c. *From the Nose, after Injury.*

The escape of the fluid from the nose as a consequence of injury does not appear to have been so frequently observed. The first suggestion of such a condition is

given by Bidloo the elder,[1] a medical writer who lived in the second half of the seventeenth century and wrote a work on surgery. In this he reports the case of a patient who had an accident to the bridge of the nose, followed by a continuous flow of a clear watery secretion from the right nostril in such quantity that within twenty-four hours 20 ounces (600 c.c.) of this fluid escaped. Later on the discharge became purulent, splinters of bone came away, and the patient died seven months after the receipt of the accident.

Blandin[2] in 1840 opined that he himself was the first to note an enormous serous flow from the nose in certain cases after injury. He pointed out the great importance of this new symptom for diagnosis, and especially for prognosis. A confirmatory observation is given in full by Robert.[3]

That recovery in such cases may be complete and satisfactory is shown by a case of Hector Cameron's.[4] A man aged 75 was thrown down stairs and suffered from "profuse bleeding from his left ear and nostril, followed by the discharge of large quantities of clear fluid. The discharge of cerebro-spinal fluid continued for several days, ceasing from the ear before it did so from the nostril." The patient recovered completely.

In the following case the discharge persisted for much longer, viz. for two months, before it finally ceased. It is important to recognise that a cerebro-spinal rhinorrhœa, if I may be allowed the term, could persist so long, as patients might present themselves for the nasal discharge some time after the receipt of the accident, to which they might possibly omit any reference. This case is recorded by Mathiesen.[5]

1 Quoted by Morgagni, 'De sedibus et causis morborum,' liber i, epist. xiv, art. 21.

2 'Gazette des Hôpitaux,' 1840, p. 205.

3 'Archives générales de Médecine,' 1845, tome ix, p. 389.

4 'Brit. Med. Journ.,' May 17th, 1884, p. 886.

5 'Norsk. Magazin for Laegevidenskaben,' p. 241, January, 1887 (from abstract in Bosworth's 'Diseases of the Nose and Throat,' vol. i, 1889, p. 266).

Traumatic Cerebro-spinal Rhinorrhœa lasting Two Months.

The patient was a boy aged 13, who had a severe fall on the left temple, following which he was unconscious for some time. The following night he suffered from vomiting and epistaxis. About two months after the accident he came under observation on account of the discharge of a thin watery secretion of a salty taste from the left nasal cavity. In the course of two hours 25 centimetres of this fluid were collected. His general health was good. Five days later the discharge ceased. Microscopical examination of the fluid revealed white blood-corpuseles, a few threads of mucus, and pavement epithelium. The fluid was of a specific gravity of 1·006, and of alkaline reaction, contained albumen, salt, and sugar, and otherwise corresponded to a cerebro-spinal fluid. The writer was in doubt if the source of the discharge was the cerebral or the nasal cavity.

It is well known that fractures of the base of the skull sometimes escape attention, and from this point of view it is advisable to bear in mind that when the anterior fossa of the skull is involved, a cerebro-spinal rhinorrhœa may not only be an important symptom, but even, as in the following case, the only one. The patient in this instance, after receipt of a fracture through the cribriform plate and the left middle fossa, was able to drive his bullock cart, partly on foot, a distance of twenty-five miles; indeed he did not seek advice until eight days after the accident, and then he only came on account of a clear watery discharge from the nose.

The case is thus reported by Vieusse:[1]

A man aged 46, immediately after a fall from a bullock-cart, was stunned, and although there was a blood-stained discharge from the left ear and from the nose, he was able to continue his journey of 40 kilometres, part of it on foot. Eight days afterwards he presented himself with a dropping of very limpid fluid from the nose at the rate of about two drops per second (? per minute). On lying down this flow quite ceased, and was replaced by a similar

[1] 'Gazette Hebd. de Médecine et de Chirurgie,' tome xvi, 1879, No. 19, p. 298.

discharge from the left ear. By placing the patient in a sitting position and then in a horizontal one, these discharges could be made to alternate regularly. The liquid was not collected; the author was so convinced of its nature that an analysis appeared useless. Eighteen days after the accident the patient died with symptoms of meningo-encephalitis. This was confirmed at the autopsy, which revealed a fracture of the base in the anterior fossa, involving the cribriform plate, and the middle fossa on the left side through the temporal bone.

Spontaneous Escape from the Nose not a Recognised Symptom.

But although this escape of cerebro-spinal fluid from the nose in traumatic cases is a recognised occurrence, and reference to it is to be found in most surgical text-books, I was chiefly interested in seeing whether a case under my own observation was unique in its spontaneous character, or whether there were already records to supply the points which are wanting to make a complete picture of this pathological condition. So far as many well-known text-books are concerned this search has been fruitless. Such classical systems of medicine as Ziemssen's ('Cyclopædia of the Practice of Medicine,' 1881) and Russell Reynolds' ('A System of Medicine,' 1872) have no mention of such a possibility, and there is no reference to it in the text-books of Bristowe ('Theory and Practice of Medicine,' 1890), Osler, or of Hilton Fagge and Pye-Smith ('Principles and Practice of Medicine,' 1891). Although, as I will show later on, this symptom appears to be frequently associated with nervous symptoms, there is no hint of it in Gowers' well-known work ('Diseases of the Nervous System,' 1893) nor in the large 'Text-book of Nervous Diseases by American Authors' (edited by Francis X. Dercum, Edinburgh and London, 1895). It is remarked by von Jaksch ('Clinical Diagnosis,' third English edition, 1897, p. 108) that "occasionally, as in cases of wounds perforating the cranium and in brain tumours, cerebro-spinal fluid may be dis-

charged through the nose. Under such circumstances, chemical analysis showing the absence of albumen and the presence of sugar, or at least of a reducing substance, will determine the diagnosis." Here, as elsewhere, it is evident the idea is not even entertained that cerebro-spinal fluid can be discharged from the nose except as a result of injury or brain tumour. Turning now to publications dealing specially with diseases of the nose, I find that the subject is in no way referred to by Morell Mackenzie ('Diseases of the Throat and Nose,' 1884, vol. ii) or Lennox Browne ('The Throat and Nose,' 5th edition, 1899). In the German edition of Mackenzie's work ('Die Krankheiten des Halses und der Nase,' Morell Mackenzie and Felix Semon, Berlin 1884) reference is made to the cases of Morgagni (p. 68), Bidloo (p. 8), and Elliotson (p. 50), and also to those of Paget (p. 51), Nettleship (p. 57), and Priestley Smith (p. 59), without suggesting the possibility that the watery flow was caused by escape of cerebro-spinal fluid. Bosworth gives instances of several cases which were obviously escape of cerebro-spinal fluid through the nose ('Diseases of the Nose and Throat,' vol. i, 1889), but he does not appear to have realised the origin of the fluid, and he groups these cases under the heading of "Nasal Hydrorrhœa" with cases of nervous coryza, suppuration in the antrum, and various other diseases of the nose. He ascribes the condition to a vaso-motor paresis of the nasal mucosa occurring in subjects of an intensely neurotic temperament. The excellent text-book of Moritz Schmidt ('Die Krankheiten der oberen Luftwege,' Zweite Auflage, 1897) has no reference to the question at issue. Rosenthal ('Die Erkrankungen der Nase,' Berlin, 1897) does not mention it, but under the title of "Rhinitis Chronica Simplex" he includes some cases which later on I will claim to be possible examples of the condition I am considering. The very encyclopædic work by various German authors, which is now issuing from the press in three large volumes ('Handbuch der Laryngologie und Rhinologie,' edited by

Paul Heymann, Wien, 1896–7–8), gives no reference to the occurrence of spontaneous flow of cerebro-spinal fluid from the nose, but simply a mention of hydrorrhœa nasalis as a watery flow which may be symptomatic of injury of the skull, of hydrocephalus, or of affections of the accessory sinuses. Spencer Watson ('Diseases of the Nose,' 2nd edition, 1890, p. 38) gives a careful consideration to the question of watery discharge from the nose, but he comes to the conclusion that "there is a possibility of the fluid being cerebro-spinal and that it escapes through a fissure in the cribriform plate of the ethmoid. That such an origin is the true one can only be after a severe injury and as a consequence of a fracture of the base of the skull."

Summary.

This last quotation summarises the generally accepted view as to the question of the escape of cerebro-spinal fluid from the nose, viz. that while it may occur as consequence of injury, and is a rare accompaniment of brain tumour, its spontaneous escape is unknown. So far from being a recognised possibility, it remains unnoticed in many of the best known and most recent publications on general medicine, nervous diseases, and affections of the nose. The 'Journal of Laryngology' in twelve years does not mention it. The thirteen volumes of the 'Centralblatt für Laryngologie' contain in the index only three references under the title of "Cerebro-spinal Flüssigkeit." It is evident that the condition is most exceptional, or else that its true nature is very rarely recognised. However, by the help of these and other references I have succeeded in tracing eight other cases where an analogous condition was undoubted, and twelve cases where it was most probable.

None of these cases have had the advantage of being so thoroughly investigated as one I am able to record, either because the opportunity did not offer, or because physiological chemistry was not till recently sufficiently advanced to speak authoritatively on the composition of the fluid. I

think it will be better, therefore, to report this case in its entirety, and then refer to those which help to make up the parts in the clinical picture of the affection.

AUTHOR'S CASE.

My patient, R. W—, is a single woman aged 25. She has been born and brought up in the country, where she has attended to the domestic duties of her mother's cottage. She first attended the Throat Hospital, Golden Square, in April, 1896. She was seen to be a healthy-looking young woman, presenting no exophthalmos, nor any striking feature suggestive of disease. Two and a half years previously she had gradually become aware of an increasing tendency to drip from the left nostril. This would occasionally stop for a week or even a month at a time, but since Christmas, 1895, it had been continuous both day and night. The nature and source of the fluid were overlooked at first, and she was treated with iron tonics, and locally with alkaline nose lotions. There was no cessation of the flow, and on May 20th, 1896, some post-nasal growths were scraped away under nitrous oxide gas. The dripping continued as before, and it remained unaltered by nasal lotions of extract of hamamelis, and a long course of Fowler's solution.

In October, 1896, the intractability of the flow caused me to give the case a fuller examination, and my interest was keenly aroused on finding that when the patient inclined her head forwards a clear watery fluid fell from her left nostril in a steady drip, much as the blood does in epistaxis. The following observations were then made. This dripping—which had at that date been unabated for ten months—runs forwards as a rule, and it escapes more rapidly when she bends her head. When she inclines her head backwards, or when she lies on her back, the liquid runs down into her throat, and she then has to swallow it. At night it sometimes runs on to her

lip, and so on to the pillow; this especially occurs if she is lying on the left (*i. e.* the affected) side. When she is in bed it also runs into her mouth and causes her to swallow, but she says that it never gives rise to choking attacks. However, her mother states that when sleeping in the same room with her she was frequently alarmed by the gurgling and choking noises made by the patient in her sleep.

She had noticed that the flow was invariably from the left side; it appeared to her to be worse when she had a cold; it had never been blood-stained nor offensive; was free from disagreeable taste and odour; its escape gave rise to no sneezing or irritation, and her sense of smell had remained quite unaffected.

She prefers to let the liquid flow forward, and in order to arrest it from dropping on to her clothes or the work she may be engaged on, she is compelled to carry a handkerchief in her left hand from morning to night. When working at a table she simply places a handkerchief directly under her nose, and allows the fluid to drip on to it. She uses five to six handkerchiefs a day, and these handkerchiefs on being dried are found to be quite pliable, and do not dry stiff as they would in cases of mere increase of mucous secretion. This point has some importance in reference to the consideration I purpose giving later on to previously recorded cases in which this fact was observed, although the indication it afforded was not appreciated.

Coming now to the examination of the nose, it is seen that there is very slight excoriation of the left upper lip and vestibular orifice. With the exception of slight congestion along the margin of the left middle turbinal, the inside of the nasal fossa is quite normal. The septum is slightly deviated, and there is a small spur on each side, though nothing but what is quite physiological. The post-nasal space is quite clear; the veins on the posterior wall of the pharynx are larger than usual. In the right nasal fossa no discharge of any kind is to be detected. If the left side is examined in the ordinary manner—*i. e.*

by tilting the head somewhat backwards,—no fluid can be detected, for in that position it runs into the naso-pharynx, and, as is evidenced by the movement of deglutition, it is then swallowed. But if the patient stands up with the head bent forwards, and the physician remains seated in front of her—as in Killian's position for viewing the posterior laryngeal wall—he will be able to see with a nasal speculum that the fluid collects between the septum and the middle turbinal, and that when this space (the olfactory cleft) is filled the liquid runs forwards between the agger nasi and the septum until it gains the upper part of the vestibule, whence it drops from the tip of the nose.

There are no carious teeth in the upper jaw; no difference between the two sides of the face is noticeable on transilluminating the head from the mouth; and there is no suspicion of any of the accessory cavities of the nose being affected.

The patient's general health is good, and she has always been considered healthy. She eats and sleeps well, does not suffer unduly from thirst, the bowels act regularly, the urine is healthy, menstruation takes place naturally, and the heart and lungs are normal. The thyroid gland is not enlarged. There is no affection of motion or sensation; the reflexes are normal; she is not subject to giddiness or vomiting. The hearing is normal. The fundus of each eye was examined, but there was no trace of retinitis or optic atrophy. This observation was kindly confirmed by Mr. Adams Frost and Mr. Vernon Cargill. The former reported her eyes to be in every way normal. Her intelligence is good and her memory is clear; she is somewhat shy and nervous, and it would appear that she dislikes being in public as she fancies that people notice her complaint and the constant use she is compelled to make of her pocket handkerchief.

As to her previous history, she has never had influenza that she knows of. She states that four years ago she was in bed for fourteen days with headache and vomiting; but her family attendant, Dr. Eadie of Yeovil, informs

me that this illness was of a bilious character, and that he remembers nothing about her case out of the ordinary character, except that her convalescence was rather protracted. She had measles and congestion of the lungs three years ago, and suffered, so she says, from a good deal of headache afterwards. Dr. Eadie was told that she fainted or had "fits," but he never saw her in any of these attacks. He writes that the headaches under treatment got better, and he formed the opinion that she was rather hysterical. I have inquired carefully into the history for indications of attacks of convulsions, delirium, or unconsciousness, but there appears never to have been anything of the sort. She has never met with any accident to her head, nor had any operative treatment to her nose.

In her family there is no trace of any similar affection. Her father was found dead on the roadside; he was a rather heavy drinker, and had twice had rheumatic fever. Her mother is alive and well, and as I have fully inquired into the rest of her family history, I need only say that it presents no bearing on her condition.

The patient informed me that she had been subject to headaches ever since childhood; these were always better when the fluid was escaping from the nose, and since the flow has become continuous the headaches have been most remarkable by their absence; indeed, now they occur only rarely and are very slight. The headaches used to last sometimes for weeks; they were most intense over the left eyebrow, outer side of left orbit, and the centre of the occipital region.

This history when considered with the one-sidedness of the flow, the absence of other possible sources, and the macroscopic appearance of the secretion, suggested to me the possibility that I had to do with a case of escape of cerebro-spinal fluid from the nose.

I therefore directed the patient to "drip" for ten minutes into a sterilised glass capsule. It was observed that in the first minute the number of drops was seven,

in the second minute six, and in the third minute five. After this the dripping continued without decreasing frequency, at the rate of five drops per minute. This average would amount to five drachms in an hour, and fifteen ounces in twenty-four hours. The fluid was sent to Dr. Hewlett, the pathologist of the Throat Hospital, who kindly sent me the following report:

"BRITISH INSTITUTE OF PREVENTIVE MEDICINE;
"31*st October*, 1896.

"The specimen of nasal fluid forwarded by Dr. StClair Thomson has the following reactions:

"1. With acetic acid it gives no precipitate, indicating absence of mucus.

"2. Boiled with Fehling's solution it gives a distinct reduction.

"3. Proteids are practically absent.

"In these reactions it resembles cerebro-spinal fluid rather than nasal mucus.

"Cultivations made from the fluid and incubated at 22° C. and 37° C., four in number, were all negative."

Four days later the same quantity of fluid was collected in a sterilised capsule, and again examined by Dr. Hewlett with exactly the same results. There was no longer any doubt that the case was as I suspected. I therefore availed myself of Professor Halliburton's kindness, and of his special knowledge as the leading authority on the chemistry of this fluid. He confirmed Dr. Hewlett's report.

Complete Analysis of the Fluid from the Nose.

"Report on fluid received from Dr. StClair Thomson, 16th November, 1896.

"The fluid was received in sterilised glass vessels in two portions. One portion stated by the patient to have been collected in the course of one hour measured 4 c.c. The other portion collected under Dr. StClair Thomson's immediate supervision in ten minutes measured 3·9 c.c. If the fluid is secreted at this rate all day, the

total quantity in twenty-four hours would be 561·6 c.c., or over half a litre.

"The fluid is perfectly clear and colourless. It looks like water. The reaction of the fluid is faintly but distinctly alkaline. The specific gravity of the fluid, estimated by weighing, is 1005. It contains a trace of proteid coagulable by heat and acetic acid; but the quantity is too small to give more than an opalescence.

"In another portion of the fluid it was ascertained that this proteid is practically all precipitable by saturation with magnesium sulphate; it is therefore a globulin.

The fluid contains a substance which reduces Fehling's solution. This substance is not sugar, as it does not ferment with yeast. A portion of the fluid was treated with excess of acidified alcohol; the proteid was thus precipitated; this was filtered off. The filtrate was evaporated to dryness over a water-bath; the dry residue was again taken up with alcohol, filtered, and again evaporated to dryness. Part was evaporated to dryness on a glass slide; the residue, examined microscopically, was seen to contain the needle-like crystals, single and in bundles, similar to those previously described and figured by me ('Journal of Physiology,' vol. x, p. 248) as obtainable from cerebro-spinal fluid (*Vide* Plate). The residue had also the characteristic pungent taste of pyrocatechin.

"The remainder of the dry residue was dissolved in water, filtered, and the filtrate reduced Fehling's solution well, but did not ferment with yeast. A control experiment showed that the yeast used was active on a sugar solution.

"The quantity of material at my disposal did not admit of a more thorough examination of it than is described above; but I have no hesitation, from what I have done, in pronouncing the fluid to be cerebro-spinal fluid.

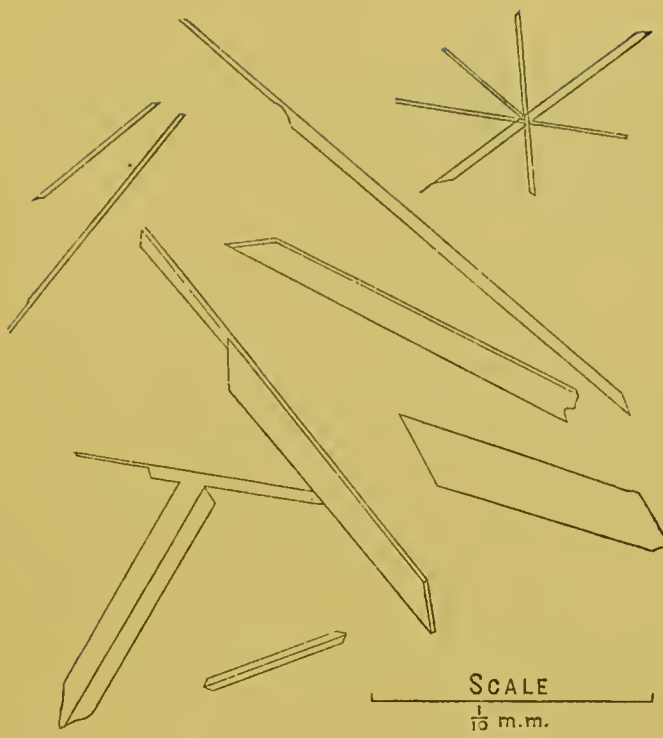
"It is like cerebro-spinal fluid in appearance, reaction, and specific gravity.

"It is like cerebro-spinal fluid in its low percentage of proteid matter (globulin) and in its absence of albumin.

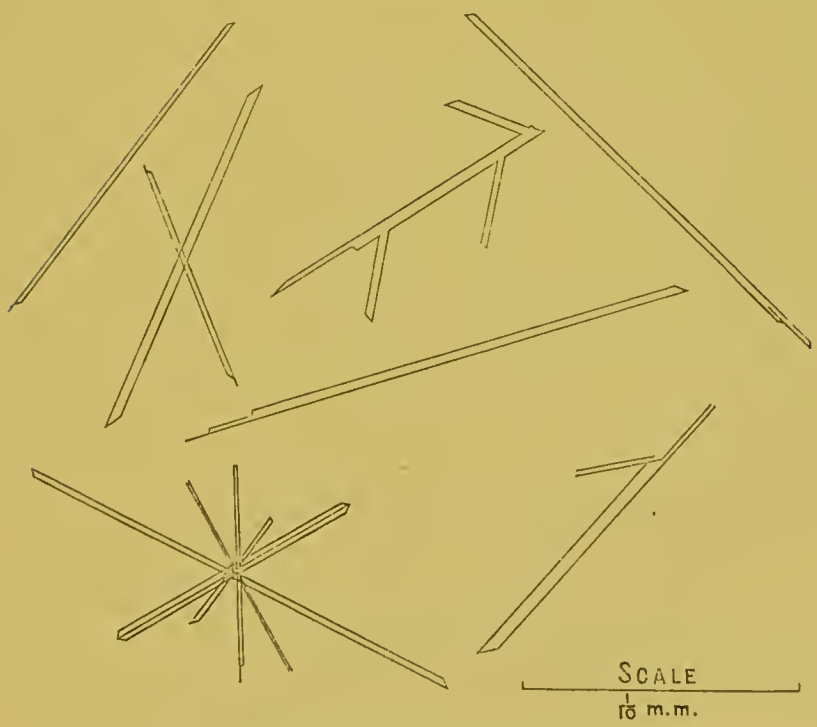
"It is like cerebro-spinal fluid in containing a reducing substance which is not sugar, which is soluble in water and alcohol, which does not ferment with yeast, and which, on account of these properties together with its taste and crystalline form, is a member of the aromatic series, probably pyrocatechin or some derivative of that substance.

"W. D. Halliburton.

"King's College, London;
"18*th November*, 1896."



Crystals of Pyrocatechin.



Crystals from Cerebro-spinal Fluid.

"Examination of other specimens of the same fluid at a later date confirmed the foregoing conclusions. I was able to determine that the reducing substance does not give the phenyl hydrazine test for sugar, and that creatinine is absent.—W. D. H.

"*February 28th*, 1899."

The Sterility of the Nasal Fossæ.

In parenthesis, I would here venture to call attention to the fact that cultivations from the secretion showed that the fluid was absolutely sterile. This confirms in a remarkable manner the results of the experiments which I had some time previously made with Dr. Hewlett, and which we had the honour of bringing before the Royal Medical and Chirurgical Society on the 28th May, 1895.[1] We there showed that nasal mucus is generally free from organisms, that it exerts an inhibitory action on their development, and that, as a rule, the interior of the healthy nose is absolutely sterile. In the case under consideration it might, of course, be advanced that infection of the subarachnoid space had not taken place as the flow was under a positive pressure, and that the outward stream of cerebro-spinal fluid would prevent the entrance of organisms. Magendie has, indeed, shown that in animals the cerebro-spinal fluid is under such considerable pressure, that when the spinal cord of a living animal is exposed and the dura mater punctured, the fluid will spurt out, sometimes to a considerable height.[2] This, of course, rapidly diminishes as the pent-up fluid escapes, though doubtless a certain pressure outwards always continues. But when cerebro-spinal fluid escapes from the external ear it is under the same amount of pressure, and as the external auditory meatus is unprovided with the methods of defence which are to be found in the nasal fossæ, infection of the fluid

[1] "Micro-organisms in the Healthy Nose," by StClair Thomson and R. T. Hewlett, 'Med.-Chir. Trans.,' vol. lxxviii, 1895.

[2] Magendie, 'Recherches sur le Liquide Céphalo-Rachidien,' Paris, 1842, p. 6.

and consequent meningo-encephalitis only too frequently ensue—at least I understand that it used to be so in the pre-Listerian days. Certainly I think it is almost without record that the cerebro-spinal fluid can trickle from the ear for two months, as the result of an accident, and yet no infection take place; but this is what happened with the escape from the nose in the case of Mathiesen (p. 9), and in my case it has been escaping from the nose for more than five years without becoming septic. This appears to me to be a remarkable clinical confirmation of our results, and strengthens us in our conclusion that the interior of the nose is automatically aseptic, and is far from being the nest of microbes which it was considered to be before our researches were published.

Progress of the Author's Case.

To return to the progress of the case. As soon as the nature of the nasal discharge had been positively determined, no intra-nasal medication whatever was attempted from fear of infection, and the patient was strongly advised to avoid all nasal lotions, sprays, &c. The patient was shown to the Laryngological Society on November 11th, 1896.[1] From the date of the analysis—16th November, 1896—to the present date, no nasal treatment has been employed, some general tonic treatment was prescribed, and the patient in the early part of 1897 returned to her home in the country. Her health remained good, and the flow was reported to be the same as before.

Intermissions in the Flow.

Only four times has it quitted her. On the 30th August, 1897, *i. e.* after it had been dripping continuously day and night for twenty months, the flow ceased, and, as she wrote, "it stopped for a clear month to the day."

[1] 'Proceed. Laryngol. Soc.,' vol. iv, 1896.

At the end of this month it gradually returned, and in the course of a fortnight it was flowing as much as ever. There does not appear to have been any cause for the cessation, nor any for the reappearance of the dropping. It could not be ascribed to any particular circumstance, nor to any treatment, for she was not having any. The flow again ceased during the months of January and February, 1898. The cessation took place gradually, and the flow roturned in the same manner. For the third time it ceased during the month of April. From the 5th of May, 1898, it continued day and night until the 18th February, 1899, when it ceased for sixteen days.

The patient states that during these cessations in the flow she was not ill ; she was able to continue her work, and was not sick, giddy, or faint. But on inquiring closely it is clear that she was more subject to headache when the dripping ceased, chiefly over the left eye and the top and back of the head. The headaches did not recur immediately on cessation of the flow, but after two or three days. They appear to have been less severe than in former years, before any dripping showed itself; but still, just at the end of February, 1898, she wrote that she had "most severe pains over the left eye and most dreadful at the back of the head." As soon as the dropping commenced again the pains ceased. With reference to the last cessation, the patient wrote : "When it was stopping I had no headache, and was in good health. Two or three days before the water returned I was in agonies of pain." The nuisance which this constant dripping is to the patient may be judged from a letter in which she wrote to say "no one knows the misery I'm in, so if you could possibly send me anything you thought would stop it I should be so glad."

Patient's Present Condition.

The patient came under observation again in October, 1898. When examined on the 6th October her general

condition was found to be as previously described. The dripping was taking place entirely from the left side, and in the same manner. Her eyesight remains unimpaired, and there is no fresh observation to add except as regards the left nasal cavity. Here a small polypus, presumably an œdematous fibroma, has formed, and is seen descending between the left middle turbinal and the septum. This has probably formed from the continuous soaking of the spongy tissues, as suggested by Bosworth in analogous conditions.

The escape of fluid was reported to be as bad as ever on the 18th March, 1899.

Other Published Cases.

Before drawing the conclusions which are justified by this exceedingly curious case, and venturing on a few speculations, I think it would be well to first place on record the cases already recorded in literature, which appear to me to resemble it, although in the majority of instances they were ascribed to some other condition than that of the escape of cerebro-spinal fluid. The comparisons which will then be available may help towards an explanation of the phenomena. I must ask indulgence for the space which these records will take up. My excuse is that I know of only one other attempt to bring together the records of several cases to show that spontaneous cerebro-spinal rhinorrhœa is a clinical possibility. This was done by Leber[1] in 1883; but, with the exception of his own case, all those he quotes are cases which I only include in a second group under the title of "most probably cerebro-spinal fluid," and six of the eight undoubted cases to which I am able to refer have occurred since the publication of Leber's paper. Bosworth's collection of cases under the heading of "nasal hydrorrhœa" contains too great a variety of pathological

[1] Von Graefe's 'Archiv für Ophthalmologie,' xxix, 1883, p. 273.

conditions to be of help in elucidating the phenomena in question.

I have placed the cases in two groups (A and B), and have numbered them in chronological order.

Group A.—Cases in which the Discharge from the Nose was undoubtedly Cerebro-spinal Fluid.

Case I.—Tillaux. 'Traité d'Anatomie Topographique,' Paris, 1877, p. 56.

Tillaux in recording his case remarks that the observation is extremely rare, if not unique :—

"An optician presented himself to me in December, 1872, for a discharge from the nose. The latter caused him no pain, but having his head constantly bent forward over his work, he was extremely inconvenienced by the incessant dropping of liquid. I thought at first of a pituitary hypersecretion produced by a coryza, and mentioned this idea to the patient; he vigorously opposed the idea, asking me to note that he had no symptoms of a cold, that the flow was not of recent date, and that it was continual, especially when he bent his head forward, a statement which he illustrated on the spot. When asked if he could supply some of this fluid the patient replied, 'A litre, if you wish it.' He calculated the amount of flow at a quarter of a litre in the day; a few days later he brought two bottles containing 200 to 300 grammes each. The fluid was analysed by M. Méhu, who reported that it was pure cerebro-spinal fluid.

"On inquiring as to the patient's previous history, I learned that he had twice been operated on for nasal polypi. I had no longer any doubt that the liquid escaped from the cranium by an opening in the roof of the nasal fossæ, on the plane of the lamina cribrosa. Further information showed that the position of the head had a considerable influence on the flow; on holding it forward, the flow was incessant; it diminished as he raised his head, and completely disappeared in the horizontal position. I have followed the patient since that period; there are variations in the flow of the liquids which has even ceased for several months without any treatment. Except for some headache from time to time the patient does not experience the least trouble, neither physical nor mental; he enjoy, all his faculties, and, as formerly, occupies himself with his business. I saw the patient last on September 20th, 1873, when the flow was as abundant as ever."

In this edition of his book the conclusion of the case is not given, but Lichtwitz[1] states that in a later edition (4e édition, 1884, p. 54), which I have not been able to procure, Tillaux adds a note to say that he had learnt that the patient had died with convulsive symptoms.

A few points are wanting in this description. We are not informed if the flow was one-sided; if the interior of the nasal fossæ was healthy; if the headache varied in relation to the flow. It is to be presumed that both eyesight and smell were intact, since the patient "enjoyed all his faculties." As to the disappearance of the flow when in the horizontal position, this statement probably depended entirely on the patient's assertion, and is to be accepted with reserve. In my own case the patient was under the impression that the flow sometimes ceased during sleep, but the evidence of anyone sharing the same room is that she is continually making swallowing movements in her sleep.

The full analysis of the fluid is not given, but Méhu was a well-known chemist, and his researches on the composition of cerebro-spinal fluid are so frequently quoted (his supply of the liquid probably coming from this case) that I think there need be no hesitation in accepting his positive report as absolutely conclusive. I would note that the flow was continuous, although subject to variations, and that during the ten months the patient was under observation it sometimes ceased entirely and quite spontaneously for months at a time. It is also particularly noteworthy that the patient died with cerebral symptoms.

Tillaux evidently connects the escape of cerebro-spinal fluid with the operation for the removal of polypi. I am surprised at this, for we know clinically, and from Zuckerkandl's researches,[2] that the roof of the nose is never the point of origin of mucous polypi. If the occur-

[1] 'Archives Cliniques de Bordeaux,' No. 12, December, 1892.

[2] 'Anatomie Normale et Pathologique des Fosses Nasales,' Traduction Française, 1895.

rence of nasal polypi in this case was not merely coincidental, it is much more likely that they were the result of the constant soaking of the mucous surfaces in watery fluid, and not the cause of its flow; unless, indeed, it is suggested that the cribriform was accidentally damaged by the surgeon.

Case II.—Th. Leber (Göttingen). "A Case of Hydrocephalus with Post-neuritic Atrophy of the Optic Nerves, and Persistent Dropping of Watery Fluid from the Nose." Von Graefe's 'Archiv für Ophthalmologie,' xxix, 1883, I, p. 273.

A girl aged 15½ first came under notice in 1877 on account of failing vision. Hydrocephalus from birth; always weakly and undersized, with large head; vision and intelligence good in childhood; vision good until fifteen years old; during the last year great failure of vision; latterly frequent short attacks of giddiness, without loss of consciousness; occasionally severe headache; two epileptic seizures. Post-neuritic atrophy in both discs; exterior of eye normal; pupils react promptly; vision reduced to counting fingers and seeing movements of hand. Stature small; with fairly well-marked hydrocephalus; circumference of head 61 cm.; nasal catarrh, enlarged tonsils, coryza, indurated cervical glands, carious teeth.

From March 12th, 1877, to end of 1881 she remained in much the same condition; there was no improvement in vision; the epileptic attacks recurred at intervals of six to eight weeks; also much oftener paroxysms of giddiness and headaches. Towards the end of 1881 all these manifestations showed themselves less often, and at Christmas, 1881, continual dropping of watery fluid from the nostril began. Up to February 5th this flow only ceased once during a period of two days.

The fluid was watery, slightly dull (from bacterial development), neutral, no mucin, only traces of albumen, little organic matter, some salts, including NaCl; except bacteria, no formed elements.

In December, 1881, as already remarked, dropping of fluid began from the nose, and in February, 1882, she presented herself again for examination. Vision had deteriorated, so that the right eye was quite blind, and with the left she could count fingers. Eye movements normal; viscera normal; urine free from sugar and albumin; intelligence intact; no motor or sensory disturbance, except loss of

sight and complete loss of smell. A watery fluid constantly dropped from the left nostril, especially when the head was bent forwards; when the head was held up, and during sleep, nothing was noticed, perhaps because the fluid flowed backwards. The flow was more plentiful in the morning than in the afternoon. Both nasal fossæ were free, nothing in the throat except enlarged tonsils. The quantity varied; once in the morning 15 drops fell in a minute; in an hour 22 c.c. were collected; in six hours 76 c.c. escaped; in seven hours and fifty minutes 32 c c. The secretion therefore fluctuated in an hour between 4·08, 12·6, and 22 c.c. 76 c.c. escaped in six hours.

Analysis of fluid.—Sp. gr. 1007–8, feebly alkaline, perfectly clear and free from odour, slightly salty to taste; gave no deposit on standing; contained a very few lymph corpuscles, which in freshly-caught drops still made distinct amœboid movements. Certain rounded cells showed in their interior very active molecular movement. On boiling, even on addition of acetic acid, no opacity; with nitric acid, slight opalescence. Trommer's test gives a very slight separation of oxide of copper. Boiling with Liquor Potassæ, a yellow colouring, which disappears on further boiling. Silver nitrate solution gave a white precipitate; on evaporation common salt crystals were obtained; on heating the slight residue on porcelain it became brown.

Occasionally the dropping ceased for periods varying from eight days to four weeks. It was reported as still present when the patient returned home. For awhile it was from the right nostril, but afterwards from the left, as before, and her general condition continued better than in previous years; headache and giddiness ceased; convulsive seizures still occurred from time to time; they were not more apt to occur during the periods of arrested dropping than at other times. Vision remained the same.

The following analysis was supplied by Professor Tollens:

The fluid turns the ray of polarised light slightly to the left. It reduces Fehling's solution very slightly (1 c.c. Fehling's solution is reduced by 6·5 cc. of the fluid). This gives, reckoning for sugar, 0·077 per cent. sugar (?). Whether the reducing substance is really to be looked upon as sugar, remains, according to this, certainly rather doubtful. In addition were found chlorides of soda and potash (shown by flame tests), traces of sulphates. Mixed with five volumes of absolute alcohol, slight fine-flaked opacity. The fluid evaporated to dryness and the residue dissolved in water leaves a little soft flaky substance, which is insoluble in water, alcohol, ether, and diluted acetic acid, and with Millon's solution gives a fine red colour (protein material). Finally, the fluid contains traces of an acid

substance which is uncrystalline, oily, and with solution of perchloride of iron, as with chloride of lime, gives a deposit, and so very likely is a fatty acid which is in solution in combination with an alkali.

From the fulness and care with which Leber records his case I gather that cerebro-spinal rhinorrhœa is not a frequent concomitant of the hydrocephalus of children. The analysis leaves no doubt as to the fluid being cerebro-spinal.

In the following case the completeness of the analysis leaves nothing to be desired; unfortunately, however, the clinical history is most meagre. I have written to Paris, but have been unable to obtain further particulars.

Case III.—J. Toison and E. Lenoble. 'Comptes Rendus de la Société de Biologie,' tome iii, Série 9, 1891. Séance du 23 Mai.

A young woman, aged 28, had four years previously had a violent fall on a staircase. The injury affected chiefly the nape of the neck. Afterwards the patient appeared to recover completely; but about four months previously (to the first date of observation, February 22nd, 1891), that is to say, towards the end of November, 1890, she was suddenly seized with a nasal discharge which was more or less abundant, at times very considerable, and which she regarded as the beginning of a coryza; but later on no other of these symptoms appeared, and the flow persisted in varying quantity. When examined for the first time on February 22nd, 1891, the liquid which escaped was found to be limpid, colourless, free from odour, very fluid. The patient complained of its saltish taste. There was little doubt that the case was one of escape of cerebro-spinal fluid. Besides, a hasty examination of a few drops of the liquid showed that it gave an abundant precipitate with nitrate of silver (chloride of sodium), and that it gave nothing with nitric acid. The patient collected all the liquid which escaped during six consecutive hours; it amounted to 75 c.c. The patient thought that on that particular day the flow was less than usual. However, if it had continued at the same rate during the whole day, the total amount for the twenty-four hours would have amounted to 300 c.c.

The following very full analysis is given:

"*Microscopical examination.*—Very few white blood-cells; no red discs, but a few short bacilli and one or two micrococci.

"*Chemical analysis.*—Colourless, odourless, perfectly limpid, alkaline, and measuring 75 c.c.

"With heat a faint cloudiness which does not disappear on the addition of a few drops of acetic acid, and which is produced even when the liquid has been acidified beforehand.

"Acetic acid produces a development of carbonic acid.

"Nitric acid gives no precipitate.

"Acetic acid and ferrocyanide of potassium give no result.

"Neutral acetate of lead gives a white precipitate, soluble in excess of the reagent.

"The liquid does not give the biuret reaction[1]; but with iodide of potassium and Millon's reagent[2] it gives a yellow precipitate (reaction of Randolph); this precipitate easily becomes red under the influence of a slight excess of the reagent.

"The density taken with the specific gravity bottle is, at + 10°, 10076. (Weight of the liquid, 62·791 gr.; weight of the water, 62·315 gr.)

"The proportion of fixed matters was made on 5 c.c., and gave—

Organic matters	0·0065 gr.
Mineral matters	0·0440 ,,
Total solids at 100°—110° . . .	0·0505 ,,

or per litre—

Organic matters	1·30 gr.
Mineral matters	8·80 ,,
Total solids	10·10 ,,

The chlorine directly measured corresponds to 6·84 gr. of chloride of sodium per litre.

"The greater part of the liquid was treated with an excess of alcohol at 95°; after twenty-four hours' rest the precipitate was collected on a filter, washed with weaker alcohol, dried, and dissolved in a small quantity of water.

"The solution became opalescent under the influences of heat. It gave a precipitate with acetic acid and ferrocyanide of potassium; it did not reduce the cupric sulphate and caustic potash, but it gave most distinctly the reaction of Randolph (or what we call Millon's reaction).

"This solution, therefore, contains an albuminoid material soluble in water after precipitation with alcohol, and giving the reaction

[1] That is, violet colour with copper sulphate and caustic potash.

[2] A mixture of the nitrates of mercury and excess of nitric acid.

which is said to be characteristic of peptones (reaction of Randolph).[1]

"The alcoholic liquids used in the preceding steps are distilled in order to collect the alcohol. The residue is taken up with water. The watery solution reduces Fehling's solution; therefore it contains the reducing substance whose presence had been observed at the beginning of the analysis.

"All the efforts made by one of us to isolate this reducing body have been fruitless, as it occurred in too small a quantity in the liquid. But we have, however, been able to show that it both reduced ammoniacal nitrate of silver, at the same time giving a metallic mirror as aldehydes do. It also deviated the ray of polarised light to the right. The deviation observed in a tube of a decimetre = + 1° 15′."

On another occasion [it is not mentioned at what later date] the quantity collected during eight consecutive hours only amounted to 62 c.c., which would only give an average of 186 grammes for the twenty-four hours. This leads the authors to remark that this shows that the flow had actually diminished; but the only conclusion it may justify is that the flow varied in quantity.

"This second sample is less transparent than the preceding, less fluid; it contains slight clouds of mucus, but is colourless.

"*Microscopical examination.*—Few white blood-discs; few short bacilli, one or two micrococci; no red blood-discs.

"*Chemical examination.*—This liquid contains a larger proportion of organic matter, and the albuminoid matter, which was isolated, as on the former occasion, does not give clearly the reaction of Randolph.

"The density at +10·5° is 10076 (weight of the liquid, 62·8010 gr.; weight of the water, 62·325 gr.). The fixed matters include—

Organic matters	0·0035 gr.
Mineral matters	0·0175 „
Total of solids	0·0210 „

Per litre the fixed matters amounted to—

Organic matters	1·75 gr.
Mineral matters	8·75 „
Total of fixed matters	10·50 „

The proportion of chlorine carried out on the ashes of 2 c.c. gave 0·033 gr. of chloride of sodium, which corresponds to 6·72 grs. of chloride of sodium per litre.

"*Conclusions.*—The results obtained may be summarised in the

[1] This reaction is not characteristic of peptones, but a pink instead of a violet biuret reaction is.—W. D. Halliburton.

form of the following conclusions, which agree generally with those of Méhu, except in regard to the reducing material.

"A. Cerebo-spinal fluid appears to normally contain some white blood-globules, a fact which is easily explicable, since the white blood-cells are found in nearly all parts of the organism.

"B. From the chemical point of view it is characterised in the fresh condition—

"1. By its alkaline reaction and by the absence of odour and colour.

"2. By a low density varying round 1007.

"3. By the constancy of its richness (*a*) in mineral matters, and amounting in our cases to between 8·30 gr. and 8·80 gr. per 1000 c.c.; (*b*) in chloride of sodium (from 6·62 gr. to 6·84 gr.).

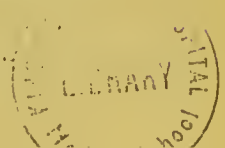
"4. By the variability and weakness in organic and albuminoid material. Probably, also, even the nature of these albuminoids is subject to variation.

"By the presence of a reducing body not pointed out by Méhu but already suspected by Bussy, of which we have always been able to prove the existence without being able to determine its nature."

Unfortunately there are no clinical details with regard to this case, other than those given in the above report. We are therefore without information as to whether the flow was continuous day and night, if it was one-sided or not, if it was accompanied by any cerebral or ocular symptoms, as to the condition of the interior of the nose, and as to the conclusion of the case.

CASE IV.—F. WALLACE MACKENZIE. "A Case of Atrophy of the Optic Nerves, with dropping of Watery Fluid from the Left Nostril." 'Transactions of the Intercolonial Medical Congress of Australasia,' Third Session, held in Sydney in 1892, p. 500.

A well-nourished, healthy-looking, intelligent lad at the age of seventeen began to suffer with severe headaches and gradual failure of sight, together with attacks in which the patient used to fall down in a sort of fainting fit. There were apparently no convulsions. Well-marked optic neuritis was found in both eyes. The sight continued to get worse, and at the end of a year a watery dis-



charge began to drop from the patient's left nostril. Coincident with this the fits ceased, and there had not been any return since (*i. e.* after the elapse of two years).

At the age of twenty—on April 8th, 1890—he presented himself to the author on account of blindness and a continual dropping of a clear watery fluid from his left nostril. There were no nasal polypi, and no diseased condition could be detected in the nose or naso-pharynx, nor was there any evidence of a diseased condition of the accessory cavities. The eyes were wide open; the pupils were partly dilated, equal, and slightly sensitive to light. V = p. l. with both eyes. There was atrophy in both optic discs, the margins being sharply defined. There were no retinal hæmorrhages. A clear watery fluid dropped continuously from the left nostril at the rate of about one ounce in an hour. On examination the fluid was found to be clear and transparent; sp.gr. about 1006. On boiling with acetic acid there was a slight cloudiness. There was a considerable proportion of chlorides and a trace of sulphates present, and the salts were principally those of potassium. In three different specimens examined there was no reaction of sugar in any.

Wallace Mackenzie is of opinion that in his case the fluid was derived from the subarachnoid space. He adds "I look upon the early symptoms and condition as being analogous to an attack of glaucoma, and the relief caused by the escape of fluid through the nose may be compared to the relief of the increased tension in the eye by the escape of fluid through the canal of Schlemm."

The above is a most carefully recorded case, and although deficient in some details it is the most complete I have yet come across in my bibliographical search. There is a distinct record of the condition of the eyes and of the interior of the nasal fossæ. I have no doubt that Wallace Mackenzie was right in regarding his case as one of nasal escape of cerebro-spinal fluid. The history of headache and failure of vision, of "fainting fits" which entirely ceased on the establishment of the flow, and the one-sidedness of the discharge, all tend to confirm this opinion. It would have been interesting to have heard if, when the loss of vision first came on, the left eye—the one on the side of the discharge—was affected before the right. The low specific

gravity of the fluid, and the absence of mucin, eliminate the possibility of an intra-nasal origin of the liquid. The analysis is particularly valuable from the negative value it brings to bear on other cases in my bibliography. The "reaction for sugar" was not obtained, although three different specimens were tested. Now the negative result of this "sugar test" is adduced by Mr. Priestley Smith for abandoning the hypothesis that the nasal fluid was cerebro-spinal in his own two cases, as well as in Mr. Nettleship's and Sir James Paget's. If it is agreed that the fluid in the present case was really of cerebro-spinal origin, it is evident that the negative finding of the "sugar test" is not to be regarded. Besides, in examining cerebro-spinal fluid the test with Fehling's solution has to be applied with some delicacy, so that the reaction might be overlooked in the hands of observers who were not used to the refinements of physiological chemistry.

Case V.—Gutsche. Dissertation, Erlangen, 1894, "Zur Pathogenese der Hypophysistumoren und über den nasalen Abfluss, sowie das Verhalten des Liquor Cerebrospinalis bei einer Struma pituitaria."
Abstract in 'Centralblatt für Laryngologie,' Bd. xi, 1895, S. 460.

"The case concerns a man, aged 34, who, being in otherwise perfect health, observed that a clear fluid flowed from his left nostril, the quantity in the course of a day amounting to about 250 c.c. When lying down it flowed into the throat. It is remarkable that in other cases this striking symptom of the flow from the nose of the cerebro-spinal fluid was never mentioned. Death ensued in about fifty-eight days after the first appearance of illness, with the phenomena of cerebro-spinal meningitis. The post-mortem showed struma pituitaria (swelling of the pituitary gland and of the chiasma nervorum opticorum), empyema of the sphenoidal sinuses and of the left maxillary antrum, and arachnitis purulenta.

"The chemical analysis of the fluid showed that it was rich in albumin, and contained a reducing substance, which, however, could not be described as sugar."

To the inclusion of this case amongst those of "spontaneous" dropping of cerebro-spinal fluid it might be objected that there was a gross lesion at the base of the brain, but here again the connection between the lesions found post mortem and the cerebro-spinal flow is not very evident. The analysis is not opposed to the view that the fluid was cerebro-spinal; indeed, the presence of "a reducing substance" supports it. The large amount of albumin is explained by the admixture with inflammatory products in the accessory sinuses.

Case VI.—Mermod. "Meningo-encephalitis consequent on the exploration of a supposed Frontal Sinus." 'Annal. des Mal. de l'Oreille et du Larynx,' tome xxii, No. 4, April, 1896.

A man aged 36 had suffered for several years from painful tickling in his nose, especially towards the root, with considerable muco-purulent secretion, which was increased in cold, damp weather; nasal respiration was frequently interfered with. The continuous current, electrolysis, and application of the galvano-cautery to the hypertrophied inferior turbinals only produced momentary relief. When examined on July 15th, 1895, he was complaining of headache, frontal or occipital, or sometimes generalised; at times it was a general heaviness of the head, which was very troublesome when he was at work. He ran much from the nose, requiring two or three handkerchiefs a day, and many more when the weather was cold or damp; the secretion was the same on both sides; he had the constant sensation of being stopped up in the nose. The nasal mucous membrane was generally very red; the inferior turbinals were not very large, their surface rough and unequal, probably the result of previous treatment. The middle turbinals were very irregular, and presented that appearance of polypoid degeneration which is habitually observed in long-standing suppuration of the accessory sinuses. The meatuses were full of muco-pus, of which it was difficult at first to discover the source, which was probably multiple. During the summer of 1895 the following treatment was carried out in various sittings:—Resection of the middle turbinals, extraction of large polypoid masses on each side from the neighbourhood of the infundibulum; opening of the right maxillary antrum by the alveolar border, and of the left sphenoidal sinus, which was found full of pus and large granulations, so that the anterior wall was resected in order to throw the sinus and the nose into one cavity.

The anterior and middle ethmoidal cells on the right side were opened, and were also found to contain pus and large granulations.

Towards the end of the summer the patient experienced a certain amount of relief, but the secretion was still very abundant. When examined on November 15th the local condition had altered. The nose was completely free; the aspect of the mucous membrane as a whole was almost normal; there was no vestige of polypus, and no trace of pus. The lining of the left sphenoidal sinus was seen to be rose-coloured, and the right maxillary sinus also no longer secreted pus. But, on the other hand, the patient asserted that he used his handkerchief more than ever, only the secretion had gradually lost its purulent character, and had become absolutely watery; also it was no longer continuous, but intermittent in character. The headache had become exclusively frontal; it was often most severe, especially on the right side, *and it diminished every time after an abundant nasal evacuation of a liquid which was clear as water* [the italics are Dr. Mermod's]—a symptom on which the patient particularly insisted. He was persuaded that there was "something" at the base of the forehead, and demanded relief in one way or another, as his work as a printer was becoming constantly more difficult for him.

As to diagnosis. Thinking that the case might be one of vasomotor hydrorrhœa, the local action of cocaine, antipyrine, and atropine were tried without avail. A cyst of the frontal sinus might be suspected, and the case appeared to coincide best with the two cases of Lichtwitz, where the nasal secretion came from the frontal sinus, and where cure was obtained by a puncture from the nasal cavity (*vide* p. 64), although, with the exception of sneezing, the nervous symptoms—such as lachrymation, photophobia, temporary hemianopsia, convulsive seizures, &c. (Lichtwitz)—were wanting. The view of an affection of the frontal sinus was the more probable, as other sinuses were involved; but why should there be pus in the maxillary and ethmoidal sinuses on the right side and the sphenoidal on the left, with serous fluid in the frontal sinus? The liquid was not thought to be cerebro-spinal, for in the curious case of Tillaux the flow was incessant—a quarter-litre in twenty-four hours—and was not accompanied by any sort of malaise; besides, this quantity varied according to the position of the head. Here there was nothing of the sort. There was no ocular disorder; vision equal on both sides; the papilla clearly limited; no venous stasis. An attempt to catheterise the frontal sinus from the nose was not successful, the curved cannula appearing to be arrested at the entrance of the infundibulum, as if it terminated in a cul-de-sac. Before resorting to Schæffer's method of puncturing the floor of the sinus from the nose another attempt was made—with every antiseptic precaution

—to pass a fine curved flexible probe up through the fronto-nasal canal. It was remarked with surprise that the instrument entered easily, without meeting with any bony resistance, into what appeared to be a vast cavity, giving the impression of a very extensive frontal sinus. On withdrawing the probe, which had penetrated to a depth of 7½ centimetres, from the nostril the patient's habitual headache was much augmented for an hour, and during the night there was an abundant serous flow from the nose. He resumed his work next day, and returned to the clinic in eight days, when the same manœuvre was repeated; but, in order to collect some of the serous liquid, a small cannula was introduced in the same track as on the former occasion, but only to the depth of 6½ centimetres. Immediately some grammes of liquid, clear as water, escaped from the cannula; the onset of sharp pain obliged the hasty withdrawal of the cannula, and so prevented the collection of the liquid. Meningo-encephalitis followed, and on the sixth day a large opening of the frontal region at the root of the nose showed that the frontal sinus was entirely absent, the position usually occupied by it being entirely taken up by the frontal lobes. A small opening existed on the right side between the skull and the nose. There were the usual indications of meningo-encephalitis, and the patient died in twenty-four hours.

At the post-mortem, examination of the base of the skull revealed the existence of two holes. The first, hardly perceptible, was situated in the dura mater, beside the apophysis crista galli, and more than 3 centimetres behind the nasal spine. It was probably through this small slit that the flow of liquid used to take place. The second opening was much further forward in the neighbourhood of the foramen cæcum, and 2 millimetres behind the posterior surface of the bony wall, or 11 millimetres from the nasal spine, and at least 1 centimetre in front of the lamina cribrosa, which had not been injured. No trace of a frontal sinus was to be found either on the right or the left side. The brain showed no sign of traumatism. At the base, around the optic chiasma and cerebellum, there was a considerable quantity of pus in the subarachnoid spaces, otherwise the base of the brain showed no sign of inflammation. On the right a focus of softening of the point of the frontal lobe invaded the two first frontal convolutions. The ventricles were very dilated and occupied with purulent serum; the ependyma was very injected and opaque. On the right the first frontal presented on section some small hæmorrhages in the white matter; the centre of softening only concerned the grey matter.

The autopsy gives no explanation of the right frontal headache; evidently, since there was no frontal sinus, the

liquid could not be anything but cerebro-spinal fluid which collected between the frontal lobe and the dura mater, escaping at intervals.

The whole profession must feel extremely indebted to Dr. G. Mermod for his full publication of this most instructive case. In the clinical record only one detail is missing, viz. the analysis of the fluid, and it was only the force of circumstances which prevented this. I cannot refrain from directing attention to some of the most important points in the above case, before passing on to consider the cases together. It shows how a skilled specialist may be misled by reference to only one or two similar cases of a condition of which there is not an established "Krankheitsbild." The example of Tillaux's case (p. 24) did not appear to Mermod to be analogous to the above, because in Tillaux's the flow was incessant and varied according to the position of the head; but my conclusions will point out that cerebro-spinal rhinorrhœa may be constant or intermittent, and that the flow may vary or be the same in different positions of the head. Again, a too close analogy with the description of the case of Lichtwitz (p. 64) helped to mislead Mermod, but when I come to consider that case I will have to point out that it is extremely probable that it also was one of discharge of cerebro-spinal fluid.

The importance of Mermod's observation will, I trust, excuse me for diverging to call attention to two practical lessons it teaches. One is, that the escape of clear watery fluid from the nose should (in the absence of gross lesions) always raise the suspicion that it may be cerebro-spinal fluid; and the other is, that it may be a dangerous proceeding to attempt to penetrate the frontal sinus from the nasal cavity.

My own case would, in chronological order, rank here as No. VII.

The following has been published since my patient was shown to the Laryngological Society.

Case VIII.—Scheppegrell. "Case of Recurrent Headache, each attack being relieved by the discharge through the Right Nostril of a Fluid from the Cranial Cavity." 'Journ. Americ. Med. Assoc.,' February 26th, 1898, p. 480.

In February, 1885, the patient, a female, suffered from a most agonising headache, the pain at times being so severe that she was entirely oblivious of her surroundings. This continued for three weeks, and was relieved by the following accident. While descending a stair the patient fell down a considerable distance, her head striking against a stone jar at the bottom of the staircase. The fall was so severe that the patient was unconscious for several seconds, but when she revived she observed that there had been a profuse discharge of a yellow watery fluid from the nostrils, and that the headache, which had persisted for three weeks, had entirely disappeared. The attacks, however, continued to recur at varying intervals, the intermissions being sometimes only twenty-four hours, and rarely more than two weeks. The headaches persisted from three to five days, and sometimes as long as ten days. On each occasion the headache terminated with a spontaneous discharge from the nostrils, principally from the right side, and complete relief. This train of symptoms still continued when the patient presented herself to the author in January, 1893. She then "stated that when these headaches commenced there was a feeling of stiffness in the neck near the collar-bone; then the pain seemed to ascend until it formed a focus in the upper part of the head near the crown, and produced a sensation as if a boil were forming, the pain extending over the whole upper part of the head, and her eyes could be kept open only with difficulty. The face is flushed, but there is no elevation of temperature. An ophthalmoscopic examination gave negative results, and there was no exophthalmos."

The right sphenoidal sinus was punctured, but no fluid escaped. The right frontal sinus was opened externally under chloroform, and found to be healthy. The ethmoidal cells were opened without benefit, and the antrum of Highmore was catheterised without giving relief.

The various accessory sinuses having now been excluded, the view was entertained that the discharge came from the cranial cavity. Some of it was therefore collected for examination. "The fluid had a specific gravity of 1005, and was slightly alkaline in reaction, and contained a small amount of albumen. Chemically the liquid resembled the cerebro-spinal fluid, and the contents of the cranial lymphatic vessels in this region, which are almost identical in

character. When this fluid was allowed to settle in a conical glass, there was a heavy white deposit; and the clear supernatant fluid was of a pale straw colour, and did not coagulate. The sediment consisted almost entirely of pavement epithelial cells, some occurring singly, and others in flakes. A few red corpuscles were seen. In a second specimen sent for examination, the admixture of blood was so large that it imparted a reddish tinge to the whole body of the liquid."

The author concludes that the fluid, which had caused the first attack of cephalalgia, had accumulated in the cranial cavity, and that the fall had been instrumental in breaking through the barrier which had existed between the liquid and the nasal cavity. But if this fluid were discharged from the subarachnoid space, it was difficult to understand why the same quantity came from the nostrils after each attack, and also why the discharge ceased so abruptly, and did not continue to drip for some time after the first pressure had been relieved. This leads the author to suppose that this peculiarity was due to a cyst connected with the lymphatic circulation in this region, possibly caused by occlusion of the efferent lymphatic vessel of the perivascular lymphatics surrounding the vein which passes from the nose, through the foramen cæcum, to the superior longitudinal sinus. "The location of such a cyst in this region would not only cause all the disturbances due to pressure in the subarachnoid space, but would also explain the limited amount of fluid which was discharged after each attack. The slight admixture of blood-corpuscles evidently came from the ruptured point in the upper part of the nasal cavity." Repeated examination has not shown any cyst protruding into the nostril.

The above case varies in many particulars from those we have already considered. The details of the chemical analysis are not sufficient, by themselves, to determine the cerebro-spinal character of the fluid, and the author still holds the older views of chemical physiologists that cerebro-spinal fluid and lymph are almost identical in character. Later on I shall point out that this opinion has been abandoned. So far as it goes, however, the analysis of the fluid is not opposed to the claim of the author that the fluid came from the cranial cavity, and his diagnosis is fully borne out by the particulars of the case. The chief point in which it differs from the other seven cases is in the cessation of the flow after a limited amount (mentioned to be about an ounce)

had escaped. As the freedom from headache—and from the nasal discharge—sometimes endured for periods of two to six weeks, it is to be presumed that a certain amount of liquid had to accumulate, sometimes slowly, before it induced headache. The author's suggestion as to how this took place is ingenious and plausible.

The following case has only been published since this work was written. It has, however, come to my notice in time to introduce it here before my manuscript was sent to the printer.

Case IX.—Körner (Rostock). "Flow of Cerebro-spinal fluid through the Nose with Optic Atrophy, a combination of symptoms probably caused by a tumour of the pituitary body breaking into the sphenoidal sinus." 'Zeitschrift für Ohrenheilkunde,' Bd. xxxiii, Heft 1, Juli, 1898.

The patient was a female aged 37, and came to the clinic on April 8th, 1896. Since the age of ten she had been deformed, and for the last eight years her gait had been weak and trembling. For some years the weakness of her eyes and hands had prevented her from working as a seamstress. About four months ago, after cough and sneezing, she began to suffer from a flow of clear watery fluid from the left nostril. This flow continued day and night uninterruptedly. When lying on her back the fluid ran into her throat and was swallowed. She is seen to be small and thin. She has a marked kyphoscoliosis.

Her mental capacities are small; she laughs much without reason, but to simple questions she gives clear and correct answers. As a rule she sits still and holds a handkerchief or a glass beneath her dripping nose. She cannot walk alone without assistance, and has to steady herself against the nearest object. Her movements are not ataxic; it appears rather as if she had a great weakness in her legs.

From the left nostril there drops incessantly a clear watery fluid. On different occasions this was collected, and each time it averaged about 15 c.c. per hour. On analysis, Professor Nasse found 1·18 per cent. of fixed matters and 0·75 per cent. of ash. The loss on ignition (Glühverlust) (0·43 per cent.) was reckoned chiefly as albumen. On account of the scantiness of the fluid the mucin could not be reckoned with certainty; the ash contained much

NaCl. In the right side of the nose nothing abnormal was discoverable. In the left side there was a considerable hypertrophy of the anterior end of the middle turbinal.

As regards the eyes, there was slight prominence of the eyeball and rotary nystagmus. The right pupil was normally dilated, the left somewhat wider. The right pupil reacted well to light, but the left did not react at all to direct light, although it did so decidedly for accommodation. There was slight insufficiency of both internal recti. The vision on the right was $\frac{5}{9}$; on the left, fingers could only be counted when held close to the eyes. On both sides there was decided optic nerve atrophy.

There was no enlargement of the thyroid gland; no signs of acromegaly. It was thought that the patellar reflexes and skin sensibility were normal, but there was no note of it in the case book. The patient was only a short time under observation; she returned home and died four and a half months after the above observations were made. The nasal flow continued up to her death. There was no autopsy.

The source of the fluid had not been recognised while the patient was under observation, and hence the observations taken were not as complete as might be desired. The hypertrophy of the middle turbinal was removed without altering the flow; the portion removed was found to be an ordinary hypertrophy. The left maxillary sinus was punctured, but no fluid was discovered in it. It was only when the author became acquainted with the case of Gutsche (*vide* p. 33) that he realised that in the above case he had had to do with an escape of cerebro-spinal fluid, and he concludes that in his own case, as in Gutsche's, it was due to a tumour of the pituitary body. He has collected the records of eight cases which have been published of optic nerve atrophy with escape of watery fluid from the nose, and suggests that in all of them both these symptoms were due to a tumour of the pituitary body. These eight cases are those of Baxter (p. 56), Gutsche (p. 33), Hardie and Wood ('New York Med. Journ.,' 1890, vol. ii, September 6th, p. 264), Leber (p. 26), Nettleship (p. 57), Priestley Smith (p. 59), and Wallace Mackenzie (p. 31).

Although the chemical analysis is incomplete in the above case, yet the physical characters of the flow, its limitation to one side, its continuity night and day, the amount discharged per hour, its association with optic nerve atrophy, and the negative examination of the nasal fossæ and their accessory cavities, are sufficient evidence as to the arachnoid origin of the fluid. I cannot agree with

Körner's suggestion that in all the cases he quotes the escape of cerebro-spinal fluid was due to a tumour of the pituitary body breaking through into the sphenoidal sinus. In Baxter's case no such tumour was discoverable at the post-mortem. A study of the case of Hardie and Wood has convinced me that it was one of vaso-motor rhinitis. In Nettleship's case the flow ceased. And in Priestley Smith's the flow lasted from two to four years, which it would hardly have done with a progressive growth at the base of the brain.

To facilitate reference and comparison the main points in these nine cases may be recorded in tabular fashion (*vide* Table A).

TABLE A.

TABLE A.—*Cases in which the Discharge from*

No.	Author, reference.	Sex and age.	Duration.	Cerebral symptoms.	Eye symptoms.	General.
I	Tillaux, Traité d'Anatomie Topographique, 1877	M., adult	"Not of recent date." Under observation 10 months	Some headache from time to time, but enjoyed all his faculties. Death with convulsive symptoms	—	Flow continuous, increasing on bending head forward, and ceasing in horizontal position
II	Leber, Archiv f. Ophthalmologie, xxix, 1883	F., 20	Commenced at age of 20	Hydrocephalus from birth. Intelligence good in childhood. With failure of vision came onset of giddiness, severe headache, and epileptic seizures	Vision good in childhood. At age of 15 failure of vision from post-neuritic atrophy	Continuous flow, but with intermissions of periods of 8 days to 4 weeks; increased on bending head forward; during sleep not noticed, probably because the fluid flowed backwards
III	Toison and Lenoble, Comptes Rendus de la Société de Biologie, tome iii, série 9, 1891	F., 28	4 months	—	—	Onset sudden
IV	Wallace Mackenzie, Trans. Intercol. Med. Congress, Third Session, 1892, p. 500	M., 20	2 years	Severe headache at age of 17, with sort of fainting fits; no convulsions. These ceased with the establishment of the nasal discharge at age of 18, and had not returned during the two subsequent years	Gradual failure of vision commenced at age of 17, with well-marked double optic neuritis. At age of 20 atrophy of both optic discs; no retinal hæmorrhages	Well nourished, healthy looking, intelligent

the Nose was undoubtedly Cerebro-spinal Fluid.

Nostril affected. Accessory cavities.	History.	Progress and results.	Quantity and character of fluid.	Diagnosis.
—	Previously twice operated on for nasal polypi	Variations in the flow of the liquid, which even ceased at times for several months without treatment. Death	¼ litre in the day. Analysed by M. Méhu, who reported that it was pure cerebro-spinal fluid	Cerebro-spinal rhinorrhœa.
Left. Both nasal fossæ free	—	Headache and giddiness ceased when flow was established. Convulsive seizures continued, and were not more apt to occur during periods of arrested dropping	Fluctuated between 4 c.c. and 22 c.c. per hour; 76 c.c. escaped in 6 hours. Full analysis given; clear, free from odour, alkaline; sp. gr. 1007-8; no albumin	Cerebro-spinal rhinorrhœa.
—	Violent fall 4 years previously	—	75 c.c. in 6 hours, or 300 c.c. in 24 hours; but on another occasion only 186 c.c. in 24 hours. Very full analysis given; absence of odour and colour; sp. gr. 1007; presence of a reducing body	Cerebro-spinal rhinorrhœa.
Left; no nasal polypi; no disease in nose, accessory cavities, or naso-pharynx	—	—	Flowed at rate of 1 ounce an hour; clear, transparent; sp. gr. 1006; no sugar reaction	Cerebro-spinal rhinorrhœa.

No.	Author, reference.	Sex and age.	Duration.	Cerebral symptoms.	Eye symptoms.	General.
V	Gutsche, Centralb. f. Laryngologie, xi, 1895	M., 34	58 days	Death from cerebro-spinal meningitis	—	Otherwise in perfect health. When lying down flow passed into throat
VI	Mermod, Annales des Mal. de l'Oreille et du Larynx, tome xxii, No. 4, 1896	M., 36	Several years	Headache and heaviness, most severe on right side, and always relieved after abundant flow of clear liquid. Death from meningo-encephalitis following exploration	No ocular disturbance; vision equal on both sides; papilla clearly defined	—
VII	StClair Thomson, The Cerebro-Spinal Fluid, London, 1899	F., 25	5 years	Headache since childhood, but absent since nasal flow was established; returning slightly during cessation of flow	Eyesight unaffected; no trace of optic atrophy or retinitis	General health good
VIII	Scheppegrell, Journ. Amer. Med. Assoc., Feb. 26th, 1898	F.	8 years	Intense headache; eyes kept open with difficulty; always relieved by flow	Ophthalmoscopic examination negative; no exophthalmos	Presumably good
IX	Körner (Rostock), Zeits. f. Ohrenheilk., Bd. xxxiii, Heft 1, Juli, 1898	F.	9½ months	Limited mental capacities	Slight prominence; rotatory nystagmus; right pupil normal, and reacted; left larger, and reacted to accommodation, but not to light; marked optic nerve atrophy both sides, worse left	Small, thin; marked kyphoscoliosis; not ataxic, but cannot walk without assistance

Nostril affected. Accessory cavities.	History.	Progress and results.	Quantity and character of fluid.	Diagnosis.
Left	—	Death. Post-mortem	250 c.c. in a day; clear, rich in albumen; contained a reducing substance which was not sugar	Cerebro-spinal rhinorrhœa.
Both nostrils; nasal polypi and hypertrophic rhinitis; empyema of maxillary antrum and anterior ethmoidal cells on right side, and left sphenoidal sinus	—	Flow intermittent. Death. Post-mortem	Clear as water. No analysis	During life, a cyst of right frontal sinus. From the autopsy, cerebro-spinal rhinorrhœa.
Left; nose, accessory sinuses, and naso-pharynx normal; no sneezing or irritation; no loss of smell	No history of accident	Four intermissions of 1 to 2 months' duration; otherwise continuous day and night	15 ounces to 561·6 c.c. in 24 hours. All the characteristics of cerebro-spinal fluid	Cerebro-spinal rhinorrhœa.
Right; accessory cavities on right side all shown to be healthy	Headache after lasting 3 weeks relieved by flow from nose, consequent on a fall	Flow ceased after an ounce escaped; recurred every 24 hours to 2 weeks, as conclusion to a headache	Watery, 1005, slightly alkaline; small amount of albumin	Cerebro-spinal rhinorrhœa.
Left	Trembling and weakness of gait preceded nasal flow by 8 years; weakness of hands and eyes for some years previously	Nothing found in nose or left maxillary antrum to account for flow	Clear watery fluid, averaging 15 c.c. per hour; 1·18 per cent. of fixed matters, and 0·75 per cent. of ash	Not diagnosed while under observation. On becoming acquainted with Gutsche's case (No. V) Körner concluded that the flow had been cerebro-spinal fluid.

Summary of Undoubted Cases of Cerebro-spinal Rhinorrhœa.

From these nine cases the following points may be summarised :

Females 5, males 4; therefore both sexes appear to be pretty equally affected.

Age from 20 to 37; therefore an affection of youth and adult middle life.

Cerebral symptoms in . .	8 cases.
Eye symptoms in . . .	3 „
Side of the nose affected mentioned in	7 „
From left side in . .	5 „
From right side in . .	1 case.
From both sides in . .	1 „
Intermission in the flow occurred in .	5 cases.
„ „ not mentioned in . .	3 „
Continuous flow, day and night presumably, in . . .	4 „
Not noticed at night . .	1 case.
No note in . . .	4 cases.
Complete disappearance of the flow in	no case.
Death in	4 cases.
„ with cerebral lesions in .	3 „
Post-mortem in . . .	2 „

The first autopsy showed swelling of pituitary body and of the chiasma nervorum opticorum, empyema of the sphenoidal sinuses and of the left maxillary antrum, and arachnitis purulenta.

The second autopsy showed that the escape of cerebro-spinal fluid had occurred through a hardly perceptible hole beside the apophysis crista galli.

We now come to the cases collected from other observers, which I have placed together in a second group and entitled "Most probably cases of cerebro-spinal rhinorrhœa," although their authors have re-

corded them under various headings. Several of them have already been claimed by Leber [1] as being what I esteem them to be, and Wallace Mackenzie [2] expresses his opinion that in six of them the fluid came from the same source as in his own case, viz. the subarachnoid space. In all, I have collected twelve cases in which the proof of the cerebral origin of the fluid is not positively certain; and although I am of opinion that the balance of evidence would justify their inclusion with the first nine cases, I have thought their consideration would be facilitated by placing them together in this second and slightly doubtful group.

Group B.—Cases in which the Discharge from the Nose was most probably Cerebro-spinal Fluid.

In chronological order.

Case X.—King. 'The London Medical and Surgical Journal,' vol. iv, 1834, p. 823.

At the Westminster Medical Society on Saturday, January 18th, 1834, "Mr. King related a case which had occurred to Mr. Rees, of Finsbury Square, who had transmitted the notes to him. A female aged 52 had excessive discharge of clear limpid fluid from the left nostril, to the amount of a quart in twenty-four hours. It had commenced three months before, and was constantly secreted night and day. It became necessary to wear a sponge for the purpose of absorbing the discharge, as, from its constant trickling into the larynx, it had several times threatened suffocation. The patient is stout, but subject to excessive action of the sanguiferous system; her eyelids are puffed; there is a florid state of the countenance, and a pulse of 96. She has a general disposition to anasarca, and the catamenial discharge, which appeared at ten years of age, and which has continued to flow ever since, is quite regular. Her diet consists of vegetables. Hitherto no local or general treatment has been found of avail."

[1] Loc. cit.

[2] 'Transactions of the Intercolonial Medical Congress,' Third Session, held in Sydney in 1892, p. 500.

Case XI.—John Elliotson. "Liquid Watery Fluid in very large quantities from the Left Nostril." 'The Medical Times and Gazette,' 1857, New Series, vol. xv, p. 290.

On July 19th, 1842, Dr. Elliotson was first consulted by a lady aged 40, in excellent general health, on account of a profuse flow of watery fluid from her left nostril. She had had a similar attack fourteen years previously. One night she had a severe pain in her head, and the next day as the pain declined the left nostril began to run, and by the evening she felt no more pain and the discharge was at its height. It lasted eighteen months, and suddenly ceased without obvious cause one night, after having been as profuse as ever the day, and indeed the evening, before.

The second attack had been going on for thirteen months when she first consulted Dr. Elliotson. The fluid was more copious than in the first attack, and as much as three quarts had been discharged in a day. The fluid was colourless, without odour, and so watery that the handkerchiefs dried soft and served again without the necessity of washing. As many as five and thirty were used in a day. When she went to bed a number of towels were placed about her face and neck, and when they became saturated she always awoke from their wetness and coldness. She was compelled to sleep nearly upright. There was no sneezing, and presumably her sense of smell was unaffected. If she stooped, the fluid streamed from her nose. She felt no thirst, and drank little more than in health. All her secretions and functions were undisturbed. Pulse 80 and good. All causes of debility, excitement, heat, and especially damp, aggravated the complaint. During the two attacks she occasionally had a cold in her head like other people, and lost her voice and sense of smell, and discharged thick opaque mucus from both nostrils, as is usual in catarrh; but then the limpid watery fluid continued to drop from the left nostril just as when she had no cold.

This second attack had arisen from no evident exciting cause, had not been preceded or attended by headache, had increased slowly, and arrived at its height in fourteen days. The treatment to which she had been subjected in the first attack was, as Dr. Elliotson justly says, "terrific." "It consisted of repeated very copious bleedings in the arms, cuppings, leeches to the nose, blistering behind the ears, each pair of blisters being kept open for a week, strong purgatives, fruitless attempts at salivation by mercury, saline draughts, and low diet." During the second attack she was treated with tannin and gallic acid in increasing doses, and secale

cornutum, but without benefit. She then consulted Sir Benjamin Brodie, who prescribed a grain of sulphate of zinc with 3 grains of extract of sarsaparilla three times a day, and an injection of 20 grains of sulphate of zinc and 1½ drachms of tincture of galls in 8 oz. of water. Three weeks after this prescription was begun the discharge declined a little, and it slowly lessened till it ceased entirely in about three months.

Hence the first attack ceased spontaneously at the end of eighteen months; the second under treatment at the end of twenty-three months. The first began suddenly and ended suddenly; the second took place slowly and declined slowly. Elliotson doubts whether the prescription effected the cure.

When free from her complaint she required much less stimulant. Instead of drinking eight or nine glasses of wine a day, three or four glasses produced just the same comfort. She was free from recurrence at the date of publication, *i. e.* fourteen years afterwards, although in the meantime she is reported by Dr. Elliotson to have suffered from dropsy of the right ovary, a condition which was cured by mesmerism.

The following analysis of the fluid is given:

Specific gravity	1·010
Water	98·885
Mucus	·104
Chloride of sodium . . . . Sulphate of soda . . . . Soda combined with mucus . . .	1·001
Traces of lime and phosphoric acid.	

The limpid character of the watery fluid and its low specific gravity point towards cerebro-spinal fluid; the rest of the analysis does not help towards any conclusion.

Case XII.—Sir James Paget. "A Case of Polypi of the Antrum in which Watery Fluid dropped from the Nostril." 'Transactions of the Clinical Society,' vol. xii, 1879, p. 43. Read November 22nd, 1878. The debate is given in the 'Medical Press,' 1878, vol. xxvi, p. 432, and in the 'British Medical Journal,' 1878, vol. ii, p. 836.

The patient was a lady 49 years of age, robust and healthy looking, and with no signs of general ill-health, or any appearance of disease in the nostrils. There was nothing like polypus or un-

healthy membrane, or swelling as of a cyst; no nasal obstruction or unusual flow of tears, no swelling or tenderness, and nothing to indicate the source of the fluid. The sense of smell was perfect. The secretion never was purulent. This fluid had been dropping from the left nostril, with rare intermissions, for eighteen months. As to her history, it was insignificant. In November, 1876, she received a heavy blow over the left frontal sinus, but it seemed to have done no harm at the time. In January, 1877, she had for one day a severe headache, such as she had never had before or since. In February she had a severe mental shock, and in May, 1877, the dropping began. From that time it had continued up to the date of publication (November 22nd, 1878). Once, in May, 1878, it ceased for a fortnight, when she had bronchitis and took morphia; and once it ceased in the night. It always flowed from the left nostril. The amount was variously calculated at "a drop every five or six seconds;" "four ounces were once collected for me in the course of an afternoon and evening;" and "at the rate of 314 grains in twenty minutes." The quantity was generally nearly uniform, but it was always increased by mental distress or by much exertion, or by straining. At night much of it collects in the nostril and is poured out when the posture of the head is changed. Not a drop has ever come from the right nostril, unless when the left nostril and upper part of the pharynx has become filled with fluid during sleep at night; and then, on turning the head downwards and to the right, the fluid pours through both nostrils.

The fluid looked like pure water, or like the fluid of the pia mater or that of an acephalocyst.[1] On standing, the slight greyish deposit showed only some granular and molecular matter and a few epithelial cells and a few round cells. One analysis reported as follows:—"100 parts of the liquid contains 1·15 of solid matter in solution, consisting of—

0·965 inorganic matter
0·189 organic „

1·154

The liquid is slightly alkaline; it contains proteid matter, probably albumen, and there is no indication of grape-sugar in it. The solid residue is probably chloride of sodium, but it contains phosphates and, I think, iron" (Dr. Russell). In another specimen, including a large proportion of fluid which had accumulated in the nostril and above the palate during sleep, the specific gravity was 1·004, and the quantity of débris much larger. An analysis made by

[1] In describing the fluid from his undoubted case of cerebro-spinal rhinorrhœa, Tillaux remarks, "Ce liquide est parfaitement clair et limpide comme de l'eau de roche; il rappelle tout à fait le liquide des kystes hydatiques."

Mr. Thomas Taylor, one year previously, showed that the specific gravity of one specimen was 1009·3, of another 1010·44. The dry solid matter obtained from 100 fluid grains of the former was 1·2 grains of the latter 1·26. The solid matter consisted of albumin 0·05, other animal matter 0·48, chloride of sodium 0·78, with traces of carbonate of soda and phosphoric acid.

Sir James Paget expressed the opinion, though speaking with much doubt, that the fluid was derived either from a frontal or ethmoidal sinus, or from the subarachnoid space or the sac of the arachnoid membrane. He thought, however, that it was doubtful, and even improbable, that the fluid was cerebro-spinal, and it was certainly not a catarrhal affection.

Mr. Lawson, who had seen the case, believed that it was cerebro-spinal fluid which escaped. He remarked that during sleep very little came away, and appositely asked, "Was this because less was then secreted, or only because the fluid was swallowed?"

Some time afterwards, when Paget's attention had been drawn to the result obtained by Sir Benjamin Brodie in Case XI, the patient was given one grain of sulphate of zinc three times a day, increasing that dose gradually to twice the quantity, while the nostril was injected three times a day with a solution of three grains of the sulphate of zinc in an ounce of water. This plan was steadily followed for about six weeks, then the dropping of fluid gradually diminished, and in two or three weeks more completely ceased. The patient remained well and active and free from all discomfort till a month after the cessation of the dropping. Then, after exposure to mental distress, fatigue, and cold, she was seized with headache, vomiting, restless delirium; "her pupils were contracted; and after this, with signs of acute brain disease becoming gradually more intense, she died comatose three days after the beginning of her illness."

At the post-mortem there were symptoms of diffuse meningitis, "and over large portions of the anterior cerebral lobes, and some parts of the base of the brain and of the cerebellum, the pia mater was almost symmetrically infiltrated with pale greenish-yellow, soft lymph. The whole base of the skull, the cribriform plates of the ethmoid bone, the olfactory bulbs and the dura mater in relation with these, were completely healthy. The examination was made the more carefully because of a suspicion that it might have been subarachnoid fluid which had dropped from the nostril. Nothing in evidence of such a supposition could be found. The lining of all the nasal cavities and sinuses, except that of the left antrum, appeared quite healthy. Of this antrum the bony walls were unchanged; its shape and size were natural, and nothing external indicated any change within. But its floor was covered with two broad-based convex polypoid growths, deep clear yellow with the

fluid infiltrated in their tender tissue, and covered with exceedingly thin smooth membrane traversed by branching blood-vessels. They were of rounded shapes, about two thirds of an inch in diameter and half an inch in depth; they looked like very thin-walled cysts, but were formed of very fine membranous or filamentous tissue infiltrated with serum. On the outer wall of the antrum were flattened soft yellow masses, which appeared the residue of one or more similar polypoid bodies collapsed after breaking or accidental injury and the escape of the greater part of the serous fluid." (The specimen is in the museum of the College of Surgeons.) The author concludes that this copious production, whether by secretion or filtration, of a fluid of less specific gravity than any produced either naturally or in disease—unless it be the subarachnoid fluid—was brought about by these polypi in the antrum. He refers to the publications of Giraldès, Luschka, and Virchow on the disease, and observes that neither in these nor in any other works has he been able to find mention of the dropping of fluid from the nostril as one of the signs of either cysts or polypi in the antrum. No conjecture is hazarded as to the cause of the fatal meningitis.

The physical characters of the liquid and its low specific gravity indicate cerebro-spinal fluid; the analysis shows nothing to oppose this conclusion.

Case XIII.—H. Fischer. "Wässerige Ausscheidungen aus einer Nasenöffnung." 'Deutsche Zeitschrift für Chirurgie,' 1880, Bd. xii, S. 369.

"A man aged 42 was in hospital because of a broken leg. The patient was otherwise perfectly healthy, but had suffered from headaches. One morning, without any apparent cause, a dripping of a turbid watery fluid like thin milk began to flow out of his left nostril, and lasted for several hours. It dripped drop by drop as in bleeding of the nose. When I saw the patient the dropping had already stopped. The quantity which escaped amounted to 200 grammes; it had a specific gravity of 1003, and an alkaline reaction. The chemical examination showed slight traces of albumin, chloride of sodium, and phosphates; under the microscope the fluid revealed no formed elements, especially no hooklets of echinococcus. The patient stated that he had this phenomenon for the third time, and that each time after it his headache was always relieved.

"Although there was no outward sign of disease of the sinus frontalis, I nevertheless thought it well to accept hydrops of the

same, which emptied itself periodically. He had no neuralgia of the fifth nerve such as Althaus demonstrated in his case ('Brit. Med. Journ.,' December 7th, 1878)." A similar observation to the above was demonstrated by Paget to the Clinical Society on the 22nd November, 1878.

The analysis does not contradict the conclusion that the fluid was of cerebro-spinal origin. The descriptions of the fluid as being "turbid" and like "thin milk" do not of course support such an idea, but this appearance might have been brought about by admixture.

Case XIV.—W. R. Speirs. "Notes of a Case in which the Principal Symptom was a Constant and Copious Watery Discharge of Watery Fluid from the Nose." 'Lancet,' March 5th, 1881, p. 369.

A man aged 55 had suffered from a constant dropping of a clear watery fluid from the nose. It commenced at first with sneezing, and he was inclined to attribute it to the irritation arising from his occupation as a tailor. Change of work, however, made no difference. There was no history of injury, and there was neither pain nor swelling at any time during the continuance of the flow. The fluid came drop by drop, but at times almost so quickly as to form a stream; an ounce was easily collected in a quarter of an hour, and at times the flow was so copious that any garment he was making became completely saturated in a very short time. The specific gravity of the fluid was not noted, but it was perfectly clear and colourless, free from smell, and, according to the patient, had no taste. It contained no albumin, and a handkerchief saturated with it did not stiffen on drying. It did not excoriate the upper lip. At night the patient was compelled to have his head raised till he was almost in a sitting posture, as when lying down the fluid ran back into his throat and caused a choking sensation. Exercise in the open air seemed to lessen the discharge. The sense of smell was unimpaired. "There was no appearance of disease in the mucous membrane of the nostril, and nothing whatever to indicate the source of the fluid." Local treatment with glycerine of tannin, tannic acid in powder, and various other astringents, and general treatment with purgatives, liquid extract of ergot, and liquor strychniæ, produced no decided variation in quantity. The patient himself experimentally adopted the plan of keeping his nostrils filled with goose grease, and the dropping gradually ceased day by

day, until within a week it had quite disappeared, after lasting for nine months. Speirs considers that the post-mortem of Sir James Paget's case proved that the fluid came from the antrum, and presuming that his case was identical he suggests that the goose grease may have filled up the fissure of communication between the antrum and middle meatus of the nose, and thereby so altered the existing condition of the structure lining that cavity as to effect a cessation of the excessive secretion.

Case XV.—E. B. Baxter. "A case of Paroxysmal Clonic Spasm of the Left Rectus Abdominis, with Symptoms pointing to the Existence of Gross Intra-cranial Disease." 'Brain,' vol. iv, January, 1882, p. 525.

Although the nasal condition is not mentioned in the title of this paper, it was for a nasal discharge associated with "nervous attacks" that a lady aged 35 consulted Dr. Baxter on November 18th, 1879. It appeared that in November, 1877, after a good deal of worry and anxiety, she began to suffer from headaches and "twitches" (as she termed them), and shortly after these symptoms made their appearance, a clear watery fluid, sometimes rather offensive, occasionally tinged with blood, began to come from the right nostril. The twitchings occurred almost daily, lasting from ten minutes to a couple of hours. They were due to a violent recurrent spasm of the left rectus abdominis, and were followed by symptoms like those of ordinary hysteria. The headaches, which were most severe, also occurred almost daily. The pain began at the root of the nose, spread round to the back of the head, and there was a constant fixed pain on the left side of the occiput. The pains were not at all periodic; they occurred almost daily, were worse during the day, and never kept her awake at night.

No relation is indicated between the headaches and the discharge from the right nostril. The right nostril was pervious. No ulceration or disease of bone could be detected by examining with the rhinoscope or from the front. The discharge was only sometimes offensive, and Dr. Baxter could never himself perceive any unpleasant odour when he saw her. The upper jaw was crowded with decayed stumps. There was no impairment of taste or smell. There never had been any loss of consciousness or intellectual confusion.

When the condition of the eyesight was inquired into, she admitted that it had been failing for some three weeks. The pupils were found to be equal and to react well; no squint; incomplete but

decided hemiopia. Shortly afterwards Mr. Nettleship reported—"V. $\frac{R.}{L.}$ 7 Jäger, ∞ $\frac{12}{50}$. Colour perception normal. Upper and outer quadrant of each f. v. either foggy or quite a blank. Neuritis of moderate intensity in either eye."

Soft uniform hypertrophy of the thyroid body was first noticed two years ago, when the present illness began. Pulse 104, regular. Nothing amiss with heart, lungs, or urine.

Her eyesight continued to fail nearly to blindness. Headaches and vomiting attacks increased. Other symptoms (nasal discharge, thyroid enlargement) unabated. She grew thinner and weaker, but her intellect remained unaffected until three days before her death, when she had convulsions and coma, and died on January 29th, 1881, *i. e.* about three and a half years after her illness began.

At the post-mortem the bones of the skull appeared to be thicker and more dense in texture than usual; but nothing in any way abnormal was discovered in the interior of the skull, the brain, or its membranes. The cavities of the sphenoid and ethmoid were opened without finding any evidence of disease; but the autopsy appears to have been imperfect.

The author remarks that "the negative result of the inspection was a surprise to me. The experience of others may, perhaps, contribute to the explanation of what remains to me inexplicable."

I would note in this record, that although the patient at times complained of the offensiveness of the discharge, it was not to be detected by the observer, and was only occasional. With the exception of the statement that it was "clear and watery" and occasionally tinged with blood, we have no full description of the fluid. There is no information as to its flowing, and no relation indicated between the flow and the headaches.

CASE XVI.—EDWARD NETTLESHIP. "Case of Optic Neuritis followed by Dropping of Fluid from the Nostril." 'The Ophthalmic Review,' vol. ii, 1883, p. 1. A paper read at the Worcester meeting of the British Medical Association, August, 1882.

An intelligent girl with somewhat prominent eyes, but of healthy appearance, aged 23, first came to St. Thomas's Hospital in November, 1881. About two years previously she was ill with palpitation

and hysterical fits, and is said to have lost her senses. She recovered from this, but six months later she "forgot her words and was upset in the brain." She was confined to bed for several weeks with much headache and prostration, and was especially enfeebled down the left side. There was no vomiting. During the illness her sight failed, became very bad, and then improved up to the state in which it was found on examination. The headache ceased, and had not returned. Twelve to eighteen months after the above illness her ocular condition was as follows:

V. { R. $\frac{20}{100}$ and 4 J., improved to $\frac{20}{70}$ by { − 1 D. sph. / − 1·25 D. cyl.
L. $\frac{20}{0}$ and 20 J. letters, not improved.

The optic discs showed post-papillitic atrophy; pupils large and sluggish; no defect of colour vision; the visual field in each eye was very much contracted, the left eye being more affected. For two months previous to this date (November 8th, 1881) she had been much annoyed by a profuse running of clear water entirely from the left nostril. The fluid is said to have given no trouble when she was in bed; it was not obviously affected by almost total abstinence from all fluid for a whole day, nor by a long course of ergot, nor by a weak salt and water douche. Dr. Felix Semon examined the patient and found the mucous membrane of the left nostril swollen and excoriated, that of the right nostril being healthy. There was no evidence of disease in the chest or elsewhere. The following is the analysis made Mr. S. Plowman, the chief dispenser of St. Thomas's Hospital:—"The fluid was colourless, but slightly ropy and opalescent. It was neutral to test paper. It contained a considerable quantity of chlorides, but only traces of phosphates and sulphates. It contained no sugar. It gave the various proteid reactions, and responded to the tests for mucin. No quantitative analysis was attempted, but albumen seemed to be present in somewhat larger quantity than mucin." It is added, "We may probably conclude from this analysis that the fluid was derived from the nasal cavities and was not meningeal." One year afterwards (*i. e.* in October, 1882) the dripping had become less troublesome, the sight had not altered, and the discs were still hazy. In the German edition of Mackenzie's book on 'Diseases of the Throat and Nose' (published in 1884) Semon writes that whence the abundant secretion originated (30·00 in two hours) was not discoverable. He adds that quite lately the patient again presented herself; the rhinorrhœa had disappeared.

The chemical analysis in this case is not distinctive of cerebro-spinal fluid. The physical characters of the liquid and the presence of mucin and albumin are, indeed,

opposed to the conclusion.[1] Still it is well to bear in mind that other secretions may have become mixed with the cerebro-spinal liquid during its passage through the nose, and that its true character might thus have been very well overlooked without recourse to the delicate and more exact tests which were not in use at the date of the publication of this case. We are therefore obliged to look to the clinical description of the case to justify its inclusion in the present paper. The symptoms on which I rely are the cerebral ones, the affection of the eyes, the negative result of the examination of the nose by a skilled observer, and the one-sidedness of "a profuse running of clear water." These points will be referred to in detail later on.

CASE XVII.—PRIESTLEY SMITH. "Persistent Dropping of Fluid from the Nostril, associated with Atrophy of the Optic Nerves and other Brain Symptoms." 'The Ophthalmic Review,' 1883, vol. ii, p. 4. (The greater part of this paper was read at the Worcester meeting of the British Medical Association, August, 1882.)

CASE 1. A man aged 28 came under observation on February 24th, 1880. In 1875 he began to suffer severe pain in the head and to have frequent attacks of vomiting. His sight began to fail soon afterwards, and within three or four months he was quite blind. He remained liable to pain in the head. In 1879, *i. e.* four years later, fluid began to drop from the left nostril. When this had continued about four months it diminished in quantity, and after a week, during which time he complained of pain in the head and drowsiness, it stopped. He slept thirty-six hours without waking, and for nearly a week was constantly falling asleep. He then brightened up again and the dropping returned, but through the right nostril instead of the left. Similar attacks of drowsiness, always preceded by arrest of the flow of the fluid, recurred from time to time, never at longer intervals than two months. In the later attacks he would lose consciousness and become convulsed.

[1] The term albumin is frequently used by clinical observers as synonymous with any proteid coagulable by heat, and would therefore include globulin. There is no attempt in the above analysis to differentiate between true albumin and globulin.—W. D. HALLIBURTON.

In December, 1881, the fluid ceased running; he became heavy, dull, convulsed, unconscious, and died. No post-mortem. Six months after the dropping had begun Mr. Priestley Smith found the right eye with faint perception of light, and the left totally blind. In both eyes media clear and the discs atrophied, horizontal nystagmus, the right eye making a considerably larger excursion than the left.

A colourless clear fluid dropped from the right nostril at the rate of about five drops per minute; collected for fifteen minutes it measured 90 minims (equivalent to 18 fl. oz. in twenty-four hours). No record of the result of examination of the interior of the nose, but he could blow freely down each nostril.

The following is Dr. MacMunn's report of the fluid:—"Reaction alkaline; specific gravity about 1007, but the quantity too small for precise determination; chlorides present in abundance; no sugar; it contained alkali albumen; mucin was also present. In the spectroscope it gave the band of *sero-lutein* distinctly; the microscope showed some mucus corpuscles and bacteria and vibrios." To this Dr. MacMunn added, "It is hardly necessary to say that it gave no reaction with ferric chloride, as it could not well have been salivary. I should be inclined to think that it probably came from the frontal sinus, as cerebro-spinal fluid is said to contain traces of sugar, or of a substance capable of reducing cupric oxide, and this gave none. . . . . There was one peculiarity about this fluid which I cannot understand, viz. it transmitted all the blue of the spectrum violet."

Case XVIII.—Priestley Smith. Ibid.

Case 2. Man aged 22, reported on February 17th, 1882. In 1876, when seventeen years of age, he was in fairly good health, but overworked and very liable to headache. One evening he suddenly called out, put his hand to his head, fell forward and became unconscious. During many months his consciousness remained more or less imperfect, and he was at times violently delirious; he had violent pain in the head, frequent vomiting and fits; he became totally blind. About four months after the onset the hospital notes said, "he answers sensibly on being pressed; can turn both eyes inwards, neither of them outwards; the eyes jerk, especially the left; there is double optic neuritis passing into atrophy." For fourteen or fifteen months afterwards he was totally paralysed in the lower extremities, and had involuntary micturition and defæcation. Two and a half years (November, 1878) after the beginning of the attack, and just as he was beginning to recover some power in his legs, fluid began to drop persistently from his right nostril.

Some months later this nostril became stopped up, and a surgeon took something from it which he called a polypus. It soon became stopped up again, as it is now; and from that time until now the dropping has been through the left nostril.

When examined by Mr. Priestley Smith on February 17th, 1882, it is reported:—His legs are weak, he cannot walk more than a hundred yards or so. Pupils dilated; no perception of light in either eye; discs atrophied; no paralysis of any ocular muscle. The right nostril is occluded by a polypoid growth; fluid drops from the left. The quantity discharged during twenty-four hours probably amounts to at least 12 to 15 oz. Occasionally the dropping stops for two or three days, and then he gets a pain in the back moving up into his head. When the flow of fluid is well re-established the pain quite disappears, "especially," the patient observed himself, "if I walk about until a good lot of water has come away."

Dr. MacMunn gave the following report of an examination of the fluid: "Reaction alkaline; sp. gr. 1008; faint band of sero-lutein in both chemical and micro-spectroscope, but much more indistinct than in the former specimen; the violet very distinct, but blue also transmitted. Heat alone caused hardly any precipitate, and boiling with a few drops of acetic acid gave only a faint turbidity. Nitric acid in the cold produced some cloudiness soluble in excess of acid. Chlorides were present in abundance; sulphates only in faint traces. No red coloration with ferric chloride. Boiled with cupric sulphate and caustic potash solution a violet reaction was produced, and a heavy brown-red precipitate formed after boiling and standing. (The violet reaction denoted a proteid only.) The liquid was principally noticeable for the small amount of albumen it contained."

In commenting on the above cases Mr. Priestley Smith says that, "in view of the fact that arrest of the dropping was associated in both cases and on many occasions with symptoms strongly suggestive of cerebral compression, it is difficult at first sight to lay aside the hypothesis of an escape of cerebro-spinal fluid; yet this hypothesis appears to be hardly tenable, for in all four of the recorded cases (*i. e.* his own two, Mr. Nettleship's, and Sir James Paget's) sugar was absent from the fluid."

He calls attention to the fact that polypoid growths were present in two out of these four cases, and suggests that some such formation in one or other of the cavities connected with the nose may have been in all the cases the origin of the disorder, though why a discharge of fluid should accompany the growth of a polypus in some cases, and be absent in all others, remains unexplained. He points out that in both his cases severe brain symptoms with eventual atrophy of the optic nerves, *preceded* the onset of the

dropping, and suggests that these may have been set up by encroachment of a morbid growth upon the upper wall of its containing cavity, *e.g.* the sphenoid or ethmoid cells—destruction of the bone and inflammation of the meninges. Such a condition, by obstructing the downward flow of the fluid through the nostril, might lead to pressure on the brain.

In the first of these two cases (XVII) the physical characters of the fluid, its reaction and specific gravity, are in favour of its being cerebro-spinal; but the analysis is in itself contradictory, and therefore inconclusive. It certainly is not more suggestive of any other physiological fluid. The clinical description, which need not here be emphasised, is sufficient for diagnosis.

In the second of Priestley Smith's two cases (XVIII) the analysis is quite conclusive of cerebro-spinal fluid. The reaction, low specific gravity, scantiness of albumin and mucin, and presence of a reducing body, are all characteristic. The clinical description is therefore all the more valuable.

I am indebted to Dr. Foxcroft, of Birmingham, for kindly obtaining the subsequent history of this case. The patient died in May, 1891, nine years after Mr. Priestley Smith's observations were made. According to the account of the friends the running from the nose continued at times up to the patient's death, and he remained quite intelligent and had no fits nor loss of consciousness. He gradually became thinner, and died of "wasting disease."

With reference to these two cases Mr. Priestley Smith has kindly written to me as follows:—"Although I came to a different conclusion at the time, I have no doubt whatever that the cases which I published in the 'Ophthalmic Review' were examples of escape of cerebro-spinal fluid."

Case XIX.—Emrys-Jones. "Atrophy of the Optic Nerves associated with Dropping of Fluid from the Nostril." 'The Ophthalmic Review,' vol. vii, 1888, p. 97. A

paper read at the meeting of the British Medical Association in Dublin, August, 1887.

A man aged 65, an engineer, consulted the author on January 21st, 1887. For twelve years he had suffered from what he called chronic influenza. He had not suffered from headaches for twenty years. The discharge had not been quite so bad for the last three years, and he thinks that when it diminished in amount his vision began to fail. The sight of the left eye began to fail markedly, that of the right eye slightly, about two years ago. No history of heredity.

Sense of taste is normal. Sense of smell is not very acute. The soft palate and the nasal mucous membrane are normal, and there are apparently no polypoid growths. There is no thyroid enlargement, and no proptosis. He has more discharge from the left than the right. He loses at least half an ounce of fluid in an hour. Indoors he feels much less annoyance, and at night notices no discharge.

Right eye: H. being corrected, V. = $\frac{6}{6}$; colour perception normal; field much contracted all round; optic disc pale and atrophic.

Left eye: V. = fingers to outer side; field much contracted all round; optic disc shows well-marked atrophy.

Dr. MacMunn reported on the fluid as follows:—"The fluid closely resembles in its character that sent me by Mr. Priestley Smith in 1883. Reaction alkaline; sp. gr. 1·035. It failed to reduce Fehling's solution, although when boiled with this the solution became violet, owing to the presence of proteid; with heat alone it became cloudy, and when acetic acid was added after boiling the precipitate became flocculent. It was slightly precipitated by ether and by absolute alcohol; it contained chlorides in abundance, and traces of sulphates. It showed the band of sero-lutein with the spectroscope.

The specific gravity and presence of some albumin and mucin in this case point to the admixture of other secretions with the cerebro-spinal fluid. But the chemical analysis is inconclusive, and does not point more strongly to any other fluid. Although cerebral symptoms were absent, I think there are other points which justify the inclusion of the case in the list.

Case XX.—John Berg (Stockholm). "Beitrag zur Kenntniss der Krankheiten der Nebenhöhlen der

Nase und zur Lehre vom Ausfliessen der Cerebrospinalflüssigkeit durch die Nase." 'Nordisk Med. Arch.,' xxi, No. 3. (From abstract in 'Internat. Centralb. für Laryngologie,' 1891, vol. vii, p. 358, and 'London Medical Recorder,' 1889, vol. ii, p. 504.)

1. Case of osteoma in the frontal sinus; operation; cure.

A man of 37, taken into the hospital on May 27th, 1887. Seven years ago and in the last year he was obliged to keep his bed on account of headaches; he was afterwards in good health, until in August his headaches commenced again, and at the same time a large quantity of clear fluid came out of his right nostril; after this he felt his head relieved. Later on exacerbations and remissions in these symptoms took place. Three times he had attacks of giddiness, and several times passing into paretic manifestations on the right side.

Present condition.—Strongly built man; pulse 60; temperature normal. The memory has become bad, intelligence diminished. He complained of constant headache, particularly over the left eye. The left eye is pressed outwards and downwards, vision normal. By palpation a hard tumour the size of a bean was found immediately behind the orbital border in the left orbit. In the middle of the forehead was a bony excrescence the size of a shilling. May 31st, operation. The enlarged sinus frontalis was opened, and the cavity was mostly filled out with a large bony tumour. After this was removed it was seen that the cavity was besides this filled with bony tumours varying in size from a hazel to a walnut. The tumours are joined together by small bony bridges; they are easily removed without its being possible to say from which point of the sinus wall they came from. The remaining space in the cavity was filled with a clear fluid.

Behind and above the wall of the cavity was, to a great extent, formed by the distinctly pulsating dura mater. The cavity reached backwards about as far as the orbit, so that the whole left frontal lobe was certainly very considerably compromised. July 5th.—The wound is healed; rarely any headache; patient is discharged. The tumour consisted of a peripheral thin, ivory bone layer, and rich diploetic tissue.

Case XXI.—Lichtwitz. 'Archives cliniques de Bordeaux,' No. 12, décembre, 1892.

The case is epitomised in the following words:—"Nasal hydrorrhœa accompanied with multiple nervous phenomena, of twenty-

nine years' duration. Considerable improvement after puncture of the right frontal sinus, followed one year later by complete cure after the spontaneous elimination of very abundant gelatinous matter from the nasal cavities." The patient, who was a woman of fifty-one years of age, related that at the age of eighteen she suddenly expelled from the back of her throat an irregular, yellowish, porous body, coming probably from the nose. She could give no further details. At the age of twenty-two she had jaundice and swelling of the face. It lasted a month, and since then (*i. e.* for twenty-nine years) she had never been well; constant colds in the head, constant sensation of heavy weight above the nose, which, however, was not obstructed. Her "colds in the head" came on without any apparent cause every week or fortnight, with a watery flow chiefly from the right nostril, and accompanied with sneezing, photophobia, and abundant lachrymation. The nasal flow was so profuse that it soaked her clothes and her work. When she settled to do some work veritable little streams formed on the wooden floor around her chair, and at night the pillows and sheets were inundated. The liquid was clear as water, and did not stiffen linen. On holding the head backwards the flow took place into the back of the throat. These attacks, which generally lasted uninterruptedly for three days and nights, were accompanied with constant somnolence, complete loss of appetite, and photophobia. There was no headache, but the attack was ushered in with shivering and general malaise; on going to bed she perspired. On the fourth day this flow gave place to a thicker secretion, which continued for twenty-four hours, and then the secretion ceased until a fresh attack a few days later. In the intervals the general malaise still continued, although mitigated, and the patient was often obliged to keep her room.

Since the age of forty-four (*i. e.* for the last seven years) the attacks of watery flow only recurred every three weeks or every month; but during this period she had become subject to whitish, gelatinous, slimy matter constantly falling into the back of her nose, especially if she bent the head backwards. This change in the nasal condition was accompanied by a long train of symptoms which are too extensive to record here; amongst them were slight failure of memory, occasional loss of consciousness, great irritation of the skin. Possibly many of her symptoms were neurasthenic, as Lichtwitz suggests. But in addition she had for these seven years also commenced to suffer from severe symptoms in her head and loss of vision. These pains started from the root of the nose and radiated over the forehead, to finish at a fixed point in the right parietal region. The pains were always aroused on raising herself from a horizontal or a sitting position, and were very severe for

from one to three minutes. On re-seating herself the pains ceased at once, and a few minutes later she could get up without pain. If she remained seated for some time, however, the pains came on when she again stood up. If she attempted to walk at this moment she saw things obliquely, being only able to see the half of an object situated above and to the left. This kind of hemiopsia persists regularly from twenty to twenty-five minutes, and disappears suddenly. The ophthalmological examination gave the following report:—R. V. = $\frac{5}{12}$, Hm. + 1·50; fundus normal. L. V. = $\frac{5}{18}$, Hm. + 1, Ast. 120° + 1; fundus normal. Slight trouble in the crystalline lens on both sides. Considerable asthenopia, preventing any continuous work. Visual field normal. Chromatopsia normal.

The urine was normal.

On March 2nd, 1891, examination showed that the nasal fossæ and the naso-pharynx were perfectly normal, except for a slight paleness of the mucous membrane. There were neither polypi, hypertrophies, nor a trace of pus. The sensitiveness of the mucous membrane appeared normal. The sense of smell was perfect, and hearing was intact. The right frontal sinus was then punctured from the nose after Schaeffer's method ('Deut. med. Woch.,' October 9th, 1890, p. 905). No pus escaped, but a considerable quantity of blood. Her general symptoms were considerably relieved, and this improvement was further accentuated by two similar tappings (the third in April, 1891). She ceased to have the attacks of watery flow from the nose, while there was much less glairy mucus falling into the back of her throat. In October and November, however, her former pains returned, and she recommenced the expectoration of abundant glairy mucus from her naso-pharynx. On November 29th this was replaced by a profuse watery flow from the right nostril. There was no headache and no lachrymation. This flow ceased next day, and there was a calm until January 10th, 1892, when there was a flow from the left nostril,—a side from which the flow had rarely taken place alone. After another interval of comfort and relief, she was seized, on March 20th, with sneezing and a watery flow from both nostrils. High fever developed, and she had to go to bed, where she remained for eleven days, expectorating from the naso-pharynx and from the nostrils, especially the right, a large quantity of yellowish gelatinous matter, in such quantities that fifteen napkins were required in one day. At the end of this period the yellowish secretion ceased suddenly, and from that date all her symptoms, which had recurred from time to time after the puncture of the frontal sinus, although in a much less degree, ceased completely.

On October 25th, 1892, she was still free from headache, from attacks of watery flow, and from the falling of thick matter into the

naso-pharynx. In reply to an inquiry from me, Dr. Lichtwitz kindly wrote on March 12th, 1897, that this patient was alive and in good health. She had not had any return of the attacks of hydrorrhœa.

(N.B.—No watery fluid escaped when the frontal sinus was punctured. The gelatinous material was expelled one year after the puncture.—StC. T.)

The author favours the view that the liquid was not cerebro-spinal, but had a nasal origin, for the following reasons:—Every attack was accompanied with other symptoms, such as are often found in the most diverse nasal affections, *e.g.* sneezing and lachrymation. Moreover, on the fourth day of the attack, the watery liquid was regularly replaced by a mucous liquid, for which one could invoke no other source of origin than the nose. The attacks resembled those of hay fever, and only differed by their appearing at any season and without external cause.

The liquid was not examined chemically or microscopically, but he ventures to think that examination would have given results similar to those obtained in cases of hydrorrhœa. He adopts Bosworth's opinion that the secretion was due to a vaso-motor paresis, the reflex cause in this case being situated in the right frontal sinus. The mucous secretion, in his opinion, was due to a chronic catarrh of the right frontal sinus, the catarrh itself being probably occasioned by the development of a cystic tumour in this cavity, and preceding the onset of the hydrorrhœa.

Other Possible Cases.

The following observations which I have come across are so suggestive of an intra-cranial origin of the nasal discharge, that I think it might be instructive to give abstracts of them. Their descriptions are not complete enough to justify their inclusion in either of the two groups in which I have arranged the preceding twenty-one cases, but in some points they help to make up the clinical picture of the affection.

Thomas Willis. 'Opera Omnia: Cerebri Anatome,' cap. xii, Amstelædami, clxxxii.

"Novi Fœminam illustrem, cephalea immani, nec non vertigine et cerebris spirituum animalium deliquiis infestari solitam; quæ cum,

à gravi paroxysmo, melius habere cœpisset, primo in Cerebri fastigio motum formicantem, velut aquæ irrepentis, senticbat: dein motu isto paulatim ante et deorsum progredicnte, demum aquæ limpidæ plures guttæ è naribus extillabant: hoc symptoma illi passim obtingere solebat, ut mimime dubitaret ægrotans, quin lympha ista ab ipso Cerebro extillaverit."

(I knew a distinguished lady who suffered from violent headaches, occasionally accompanied by vertigo and loss of the animal spirits. When recovering from a severe attack she felt as the earliest sign a creeping movement in the brain, as of the rushing of water. Then this feeling spread from the back to the front of the head, and finally several drops of limpid water escaped from her nostrils. As she frequently suffered from these symptoms the patient had little doubt that this lymph was really distilled from her brain.)

MORGAGNI. 'De Sedibus et Causis Morborum,' liber i, ep. xv, art. 21.

In June, 1745, Morgagni was consulted by a Venetian lady who for several months had been much inconvenienced by a discharge from the left nostril. At first it was a coryza with much acrid discharge, but afterwards the secretion was as clear as pure spring water, and came drop by drop. As much as half an ounce an hour escaped. When lying down it flowed into the throat in much less quantity, so far as one could judge. The patient became thinner, and consulted the most celebrated doctors without relief. Morgagni tried a derivative medication. Afterwards he heard that the dropping lasted many months, and then slowly declined and disappeared within a year.

NOTHNAGEL. "Tumour of the Corpora Quadrigemina; Hydrocephalus; Escape of Cerebro-spinal Fluid through the Nose," 'Wiener med. Blätter,' Nos. 6, 7, and 8, 1888 (ref. in 'Centralb. f. Laryngologie,' Bd. v, 1889).

In a patient aged 17, who had been nearly three years under treatment for hydrocephalus acquisitus, there occurred in the last few weeks before death a plentiful flow of liquid from the right nostril, and in a slight degree from the right eye. The chemical examination of the fluid showed that it had to do with cerebral fluid, of which altogether more than two litres escaped. This flow

often intermitted, and on the last occasion of its intermission such an increase of diffuse brain symptoms took place that it led to rise of temperature and death. The sense of smell had diminished for years, and in the latter month disappeared altogether. The rhinoscopic examination and the post-mortem showed that the nose, the lamina cribrosa, the dura, the brain, and the walls of the enormously distended lateral ventricles were undamaged; on the other hand, the fourth ventricle was found to be shut off by the tumour from the aqueductus Sylvii. The flow could not, therefore, have originated in the ventricles, but in the subarachnoid space. The liquid must have escaped either through the lymph channels themselves, or along the perineural sheaths of the olfactory nerves. This last possibility is all the more worthy of consideration as the olfactory nerve itself was atrophied from pressure. The intermittence and the one-sidedness of the flow is not explained. The flow from the eye is explicable either by the supposition that the fluid from the nose penetrated along the tear duct into the conjunctival sac, or through a communication between the arachnoid space and the eye.

GROH. 'Wiener med. Blätter,' No. 9, 1888. Ref. in 'Centralb. für Laryngologie,' v, January, 1889.

Groh mentions the case of a boy of 14 years who was imbecile, and suffered from well-marked hydrocephalus. Whenever he lay on the right side he had a flow of a clear serous fluid out of the right nostril. Groh can give no further particulars, as it is many years since the patient was under his observation, and since that time he has not been seen.

EDWARD MEYER. The 'Ophthalmic Review,' vol. vii, 1888, p. 99.

At the meeting of the British Medical Association in 1887, and in the debate on Mr. Emrys-Jones' paper, Dr. Edward Meyer mentioned a case which he had seen with von Graefe, in which there was neuro-retinitis with nasal discharge and headache. Also a case recently met with in his own practice, in which there was a nasal discharge for a time, and when the discharge stopped cerebral symptoms were developed; there was progressive atrophy of the optic nerves without neuritis; vision was still good enough for the rough work of a porter.

Berg. Case 2.—"Hydrops of the Sphenoidal Sinus; Trephining the Sphenoid Cavity; Cure," 'Centralb. f. Laryngologie,' 1891, vii, p. 358 (same references as for Case XVIII).

Woman of 25. In spring of 1876 her sight began to get weak; patient on that account was treated by Dr. A. Berg from 1877 to 1883. In 1885 headaches and exophthalmos showed themselves, and at intervals an abundant flow of clear yellowish, and at the commencement slightly blood-stained fluid came from the nose. The pain diminished as long as the discharge lasted. A painful sensation of weight in the head set in. The author saw the invalid for the first time in May, 1886. Considerable exophthalmos on both sides, the movements of the eyes free, no tumours in the orbits to be felt. Only perception of light is retained. Optic nerve atrophy, no deformity of the nose. No other cerebral symptoms. The roof of the naso-pharynx appeared slightly depressed. In consequence of the constant headaches the patient's life is unbearable; she is ready to try everything to find relief. On June 1st, 1886, the enucleation of the right eye was first undertaken; the lamina papyracea was laid open, and at the back a centimetre of this bone was removed with the chisel. In this way the posterior ethmoidal cells were opened, and while the operator was driving backwards through the cells by means of light strokes with the hammer and chisel he opened the anterior wall of the sphenoidal sinus. This was followed by a flow of clear fluid which filled the whole orbit. The depth of the operation cavity was measured with a probe, and showed the distance of the sphenoidal sinus from the orbit in the skeleton. The cavity was drained with a drainage-tube. It healed well in six months, the patient's head was free. The cavity remained long draining; the soft rubber tube was changed in May, 1887, for a silver tube. On October 17th, 1887, it was necessary again to widen the fistula with spoon and chisel; one could then introduce the finger into the sphenoidal cavity and so be convinced that it was free. Since then the patient has felt well. In September, 1888, another clearing out of granulations with the spoon was undertaken. In the left eye there is still only perception of light. The headache disappeared immediately after the operation, and the patient's general condition improved.

Flatau. Berliner Laryngologische Gesellschaft, April 17th, 1896, 'Centralb. f. Laryngologie,' Bd. xii, 1896, S. 558.

Flatau showed a patient with adenoid vegetations and a chronic hydrorrhœa which had lasted six years, and attributed by the patient to a galvano-cauterisation of the nasal mucous membrane. The discharge from the nose was so plentiful that it sometimes amounted to half a litre.

'Twentieth Century Practice,' vol. vi, 1896, p. 43.

In his notice of rhinorrhœa Prosser James describes the following case:—"In November, 1878, Mr. P— came to me with a request from his attendant that I would take him in hand, and do what was possible to relieve his sad state. He was evidently of a highly neurotic disposition, and said he was in despair and had contemplated suicide. He had for months been troubled with a constant discharge day and night from both nostrils, in front and into the throat. He estimated the amount at two pints in the twenty-four hours, but so large a proportion flowed into the fauces that it was impossible to be accurate. At night it saturated the pillow. He could not lie on his back, as it produced spasmodic cough. The membrane looked rather pale and sodden, very slightly swollen. The fluid could be seen trickling into the pharynx. Nothing further was discovered by careful and repeated examinations. The discharge was quite bland and unirritating, never once excoriating the lip. Even the pharynx was not congested. The fluid had a specific gravity of 1·010 to 1·015, and contained a little albumin and mucin with traces of sodium chloride and phosphate. This gentleman came to me at intervals until the following February, after which he ceased to attend. During these months there were fluctuations in the amount of discharge, so that at times he was much encouraged and at others depressed. Some months afterwards he called to explain his absence, which was caused by an attack of typhoid fever from which he recovered very slowly, but when convalescence set in he found to his great satisfaction that his nasal trouble had completely disappeared."

The analysis of the fluid in the above case is too meagre to settle the diagnosis. It does not point distinctly to cerebro-spinal fluid, nor, on the other hand, does it

negative such a supposition. As to the clinical account, the fact that the flow was from both nostrils is not decidedly in favour of the view that the discharge came from the cranial cavity; but it is well to remember that in Case VI it is noted that the liquid came from both sides, although the positive evidence of the post-mortem showed that a communication existed only on one side. On the other hand, the fact that the flow was also continuous by night is suspicious, and so is the presumably negative condition of the nasal fossæ.

I need hardly add that in my search for the cases which have been here considered I have read through a very large number of records of instances of nasal hydrorrhœa—which after all is only a symptom, and not a disease,—where the fluid was undoubtedly secreted by the mucous surfaces of the nose or its accessory cavities.

The main points of these twelve probable cases of cerebro-spinal rhinorrhœa may be tabulated as follows (*vide* Table B).

TABLE B.

TABLE B.—*Cases in which the Fluid discharged from the Nos*

No.	Author, reference.	Sex and age.	Duration.	Cerebral symptoms.	Eye symptoms.	General.
X	King, Lond. Med. and Surg. Journ., iv, 1834, p. 823	F., 52	3 months	—	—	Patient stout; puffy eyelids; disposition to anasarca
XI	Elliotson, Med. Times and Gaz., 1857, New Series, vol. xv, p. 290	F., 40	23 months	First attack preceded by severe pain in head, which ceased when flow became established	—	All her secretion and functions wer undisturbed
XII	Paget, Trans. Clin. Soc., xii, 1879, p. 43	F., 49	18 months	Very severe headache 4 months previous to onset of flow. Death from meningitis	—	—
XIII	Fischer, Deut. Zeits. f. Chir., 1880, Bd. xii, s. 369	M., 42	Several hours	Suffered from headaches, which were always relieved by flow	—	Otherwise perfectly healthy
XIV	Speirs, Lancet, 1881, March 5th, p. 369	M., 55	9 months	—	—	—

as most probably Cerebro-spinal Fluid (in chronological order).

Nostril affected. Accessory cavities.	History.	Progress and results.	Quantity and character of fluid.	Diagnosis.
Left	—	Continuous day and night; had to wear a sponge. No treatment, local or general, of any avail	A quart in 24 hours; clear limpid fluid	—
Left; no sneezing; no anæmia	Similar attack 14 years previously, lasting 18 months	Continuous day and night. Result: complete disappearance, and no return after 14 years	3 quarts in a day; colourless, no odour; handkerchiefs dried soft. *Vide* Analysis	—
Left	History insignificant	Continuous day and night; quantity generally uniform, but always increased by mental distress, by exertion, or by straining; ceased once for 14 days, and once in the night; otherwise continuous. Result: death	4 onnces were collected in an afternoon and evening, like pure water, or the fluid of the pia mater, or that of an acephalocyst. *Vide* Analysis	In life, derived from frontal or ethmoidal sinus; after autopsy, brought about by polypi in left antrum of Highmore.
Left	—	This phenomenon had occurred three times	Turbid watery fluid, 200 grammes in course of several hours. *Vide* Analysis	Hydrops of frontal sinus, which emptied itself periodically.
—	At first attributed to stooping position as a tailor	Continuous day and night; ceased after introducing goose grease into nose	An ounce in quarter of an hour; at times copious; handkerchiefs dried soft	Dropsy of maxillary antrum.

No.	Author, reference.	Sex and age.	Duration.	Cerebral symptoms.	Eye symptoms.	General.
XV	Baxter, Brain, iv, Jan., 1882, p. 525	F., 35	3½ years	Preceded by headaches, and severe headaches continued with establishment of flow; vomiting, convulsions, coma	Subsequent to onset of dripping from nose came double optic neuritis, hemiopia, and later, blindness; most marked in right eye	Hysterical
XVI	Nettleship, Ophthal. Review, ii, 1883, p. 1	F., 23	1, and possibly 3 years	18 months previously "lost her senses, forgot her words, and was upset in her brain," with headache and prostration; when sight failed headaches ceased	Sight failed 12 months before running from nose appeared; post-papillitic atrophy; left eye worse	Palpitation and hysterical attacks; some loss of taste and smell; weakness of left side of body
XVII	Priestley Smith, Ophthal. Review, ii, 1883, p. 4	M., 28	2 to 3 years	Four years previously severe headaches and vomiting. Once flow of fluid ceased, and he had drowsiness. A second time flow ceased, and he became convulsed, unconscious, and died	After headaches began, failure of sight set in; double optic atrophy (worse left), and blindness in 4 months. Horizontal nystagmus	—
XVIII	Priestley Smith, Ophthal. Review, ii, 1883, p. 4	M., 22	4 years	At age of 17, after overwork and headache, sudden pain in head and unconsciousness; pain, vomiting, delirium, and fits during 4 months; for 14 months paraplegia, involuntary micturition and defæcation	During unconsciousness became totally blind; double optic atrophy	Dropping commenced 2½ years after the beginning of the attack
XIX	Emrys-Jones, Ophthal. Review, vii, 1888, p. 97	M., 65	12 years; eye symptoms for 3 years	No headache for 20 years	Discharge diminishing for 2 years, during which time his sight had been failing; atrophy of optic discs, more marked on left side	Taste normal; smell not very acute

Nostril affected. Accessory cavities.	History.	Progress and results.	Quantity and character of fluid.	Diagnosis.
Right	Came on after worry; symptoms overlaid with hysterical manifestations	Steadily grew worse. Died comatose. Post-mortem negative	Clear watery fluid; only occasionally offensive to patient, not to others; and sometimes blood-tinged	—
Left	Healthy appearance; no vomiting	Fluid is said to have given no trouble when she was in bed; no treatment efficacious; sight did not alter; flow ceased	Profuse running; fluid colourless, slightly ropy; no sugar, but albumin and mucin. *Vide* Analysis	From the analysis it is concluded that the fluid was derived from the nasal cavities, and was not meningeal.
Left, but after cessation of one week, through the right nostril	—	Four months after it started, flow ceased for 7 days. Ceased again before death. No post-mortem	5 drops per minute; 18 ounces in 24 hours. Colourless, clear, 1007; no sugar	Difficult to lay aside the hypothesis of cerebro-spinal fluid, but not tenable in view of analysis.
Right, and when this became occluded with polypus, from the left	Some recovery in legs. Intelligence quite regained	Occasionally dropping stops for 2 or 3 days, when he gets a pain in his head; when flow is re-established the pain quite disappears	12 to 15 ounces in 24 hours; sp. gr. 1008; alkaline; no sugar; small amount of albumen	Same as in Case XV.
More from left than from right	—	Discharge is less indoors, and not noticed at night	Half an ounce an hour; alkaline; 1035; no sugar	—

No.	Author, reference.	Age and sex.	Duration.	Cerebral symptoms.	Eye symptoms.	General.
XX	Berg, Centralb. f. Laryngol., vii, 1891, p. 358; Lond. Med. Record, 1889, ii, p. 504	M., 37	9 months	Seven years and one year previously severe headaches; giddiness; right-sided paresis; constant headache over left eye	Left proptosis	Memory bad; intelligence diminished
XXI	Lichtwitz, Archiv. Clin. de Bordeaux, No. 12, Déc., 1892	F., 51	29 years	Pains in head; attacks ushered in with somnolence, loss of appetite, and photophobia; vague pains in all the body, especially in the nails	Asthenopia; fundi normal	Smell and hearing intact; urine normal

Nostril affected. Accessory cavities.	History.	Progress and results.	Quantity and character of fluid.	Diagnosis.
Right	—	Osteoma of left frontal sinus removed; recovery from operation; headache rare; presumably hydrorrhœa ceased	Clear fluid	Cerebro-spinal rhinorrhœa
Right	—	Flow continuous day and night; improvement after puncture of right frontal sinus, followed in one year by spontaneous elimination of abundant gelatinous matter and complete cessation of hydrorrhœa	Clear as water, and did not stiffen linen; so profuse as to soak clothes	Vaso-motor rhinitis excited by chronic catarrh of right frontal sinus.

Summary of Twelve Probable Cases of Cerebro-spinal Rhinorrhœa.

From these twelve cases the following points may be summarised, and it will be seen that when compared with Table A our conclusions have to be both amplified and modified.

Females 6, males 6; this confirms the previous conclusion that both sexes are equally affected.

Age from 22 upwards to 51, 55, and 65; this shows that it may appear at any period during adolescence.

Side of nose affected, five times left; once it was more from left than from right; twice it alternated; three times right; once not mentioned. This confirms the conclusion of Table A that the left side is more frequently affected.

Cerebral symptoms in nine cases, eye symptoms in five cases.

Intermission in the flow in . .	6 cases.
Flow continuous day and night in .	5 ,,
Not noticed at night in . .	2 ,,
Not mentioned in . .	5 ,,
Complete disappearance of the dropping without bad symptoms in .	4 ,,
Death with cerebral symptoms in .	3 ,,
Post-mortem in . . .	2 ,,

The first autopsy (Case XII) showed diffuse meningitis and polypi in the maxillary antrum of the affected side. In the second case (Case XV) the result of the examination was entirely negative. Nothing abnormal was discovered in the interior of the skull, the brain, or its membranes. The cavities of the sphenoid and ethmoid presented no evidence of disease.

Diagnosis from Nasal Hydrorrhœa.

Before commencing to comment on these cases I think it advisable to first of all clear up two different explanations which may be offered in regard to them. The first is that the flow was from the nasal mucous membrane itself. This, indeed, is the theory of Bosworth in reference to several in my second group. Now excessive watery discharge from the nasal mucosa is of course a physiological possibility. We know that the turbinals are freely supplied with blood-vessels, elastic tissue, unstriped muscular tissue, and large blood-spaces,—in fact, erectile tissue capable of speedy engorgement, and of so much watery secretion that even in the condition of health it yields sufficient to completely saturate the inspired air. The amount of water which is thus being constantly secreted by the nose must vary greatly ; for not only does it depend on the degree of moisture in the inspired air, but also on diet, exercise, &c. It may be roughly estimated from 350 to 1400 grammes per diem.[1] It is not surprising that under diseased conditions this special secretory arrangement should yield a much larger supply of liquid. The following is a very marked case of hyper-secretion from the nasal mucosa.

Illustrative Case of True Nasal Hydrorrhœa.

E. Poulsson. "A Case of Hydrorrhœa Nasalis," 'Med. Soc. Christiania Reports,' 1895. From abstract in 'Journal of Laryngology,' vol. xi, 1896, p. 114.

[1] Aschenbrandt, 'Die Bedeutung der Nase für die Atmung,' Würzburg, 1886; Kayser, "Die Bedeutung der Nase für die Respiration," 'Pflüger's Archiv,' Bd. xli, 1887; Bloch, "Zur Physiologie der Nasenatmung," 'Zeitschrift f. Ohrenheilk.,' Bd. xviii, 1888; MacDonald, 'Respiratory Functions of the Nose,' London, 1889; Schütter, 'Annales des mal de l'Oreille,' April, 1893.

(The case is also published in the 'Norsk. Mag. f. Laegevidenskaben,' 1895, 441.)

A man aged 30, otherwise healthy, commenced in his thirteenth year to suffer three and four times yearly from attacks of excessive nasal secretion, lasting three and four days, The attacks by degrees became more and more frequent, the secretion more abundant and watery, while the duration of each attack was shorter. The attacks now generally appear every second week, and last one or two days; they commence generally in the morning with a sensation of irritation in the nose and pressure over the forehead, and when the patient gets out of bed the secretion becomes so abundant that it is impossible for the patient to do anything but to sit quietly and let the fluid flow into a basin; when obliged to move about he must hold a handkerchief constantly to his nose. This flow continues until about two o'clock at night, when he generally falls asleep, the discharge then leaving off until the following morning, when he wakes up to suffer again like the previous day, until the flow suddenly stops during the afternoon. The quantity of fluid discharged during an attack is estimated to be about one litre. The examination of the fluid gave the following result:—Watery, white opalescent fluid of slight alkaline reaction; specific gravity, 1·006—1·007; 0·02 per cent. of albumen, 0·93 per cent. of salts, principally chloride of sodium and iron, and small quantities of a fatty substance; microscopically white corpuscles. The examination of the nasal cavities did not reveal any abnormality. The patient had tried various treatments without any result. Atropine in a one tenth per cent. solution had been prescribed, and the patient had derived great benefit from the drug, ten drops of the solution being often able to check the attacks or to lessen their intensity; and although this medicine had been taken for a considerable period of time, no ill effects had been observed. Dr. Poulsson considered the affection to be of a purely nervous character, but would refrain from giving any opinion as to whether it must be considered an affection of the fifth nerve or of the sympathetic.

This case is undoubtedly one of pure hydrorrhœa nasalis; the intermission in the attacks, the onset with local irritation, the cessation during sleep, the bilateral flow, and the analysis of the fluid all confirm this view. But the case arrested my attention chiefly from the large amount of fluid which was secreted, so I wrote to Dr. Poulsson asking for some further details, which he most kindly supplied. At the date of his letter in March,

1897, the patient was still subject to these attacks. It had been impossible to measure the amount of secretion in an hour, but during an attack of two days it had amounted to one litre. It flows equally from both nostrils. The attacks are nearly always ushered in with sneezing; this sneezing ceases when the flow is fully established. The patient is not subject to headaches, and finds no relief from the secretion; indeed, he always feels unwell and tired both during and after the attack. The attacks recur quite irregularly, the intervals varying from a few days to a few weeks; as a rule he has two attacks per month. Examination of the nasal fossæ and accessory sinuses showed no pathological changes; during the flow the mucous membrane becomes swollen. Finally the patient's eyesight is quite normal.

Dr. Poulsson further increased my indebtedness to him by sending me from Christiania a bottle of the nasal secretion, and I am thus enabled to submit and contrast the analysis of a typical and undoubted case of real hydrorrhœa nasalis with that of a nasal flow of cerebro-spinal fluid. Professor Halliburton's report is as follows:

Chemical Analysis of Secretion in Nasal Hydrorrhœa.

"King's College, March 8th, 1897.

"I have examined the Norwegian fluid, with the following results:

"In the first place, it gives a precipitate of a viscous character with acetic acid. This indicates the presence of mucin or of a mucin-like substance. I collected this precipitate, and boiled it with dilute sulphuric acid for some time; then neutralised and filtered. The filtrate did not reduce Fehling's solution. This shows that the substance in question is not true mucin; or if it is true mucin, the quantity at my disposal was too small to admit of my obtaining any reducing substance from it.

"The rest of the original fluid was diluted with about four times its volume of absolute alcohol. The precipitate of proteid matter that resulted from this treatment was much more abundant than in cases of cerebro-spinal fluid. The precipitate was filtered off, and both precipitate and filtrate examined.

"(1) The precipitate.—This was dissolved in saline solution, and was found to be composed of the mucinoid material just referred to, together with a small amount of proteid coagulable by heat. Proteoses and peptones were absent.

"(2) The filtrate was evaporated to dryness at 40° C., and the dry residue consisted of salts, mainly sodium chloride. The residue also contained a substance which reduced Fehling's solution. This substance gave the phenyl-hydrazine test for sugar, and also the fermentation test with yeast. After the action of yeast no reducing substance was left in solution.

"The conclusion I draw from these experiments is that the fluid is not cerebro-spinal fluid. It contains a mucinoid substance which is absent from cerebro-spinal fluid. It contains more proteid matter than cerebro-spinal fluid; further, the reducing substance in it is sugar, and not the peculiar reducing material in cerebro-spinal fluid.

"I regard the fluid as a serous exudation; such fluid usually contains sugar. The mucinoid material is doubtless from the nasal mucous membrane.

"Microscopically a few colourless corpuscles; no hooklets.

"W. D. Halliburton."

In order to still more fully contrast the chemical characters of the fluid in cerebro-spinal rhinorrhœa with the liquid obtained in cases of ordinary nasal hydrorrhœa (vaso-motor rhinitis), I collected some of the latter from one of my own female patients during an attack. This was submitted to Professor Halliburton, who most kindly sent me the following exhaustive report:

"The fluid is thick and viscid, and slightly opalescent. On microscopic examination it shows the usual appearances presented by mucus, viz. amorphous matter with mucous corpuscles.

"It gives with acetic acid and also with alcohol a stringy precipitate like that given by mucin. On boiling this precipitate with dilute sulphuric acid a reducing sugar-like material is formed; this also is characteristic of mucin.

"The fluid contains a small amount of proteid coagulable by heat; it does not reduce Fehling's solution. Proteoses and peptone are absent. The alcoholic extract of the fluid contains no reducing substance.

"Analysis gives the following results:

"Water	98·792	per 100
Total solids	1·208	
Proteids (including the mucin)	0·260	
Other organic substances	0·163	
Inorganic substances	0·785	

"The presence of mucin and absence of reducing substance, as well as the percentage of proteids and solids, are quite sufficient to distinguish this fluid from normal cerebro-spinal fluid. The fluid resembles the Norwegian fluid on the whole, but is more viscid and richer in mucin.

"W. D. Halliburton,
King's College, London.

"*October* 17*th*, 1897"

Other Points of Diagnostic Difference.

Such cases, in a milder form, are not uncommon, and the points which distinguish them are the following:—The flow takes place almost invariably from both nostrils, although sometimes more from one than from the other. It is not noticeably influenced by the position of the head. It ceases during sleep. It is, as a rule, preceded or accompanied by other signs of irritation of the mucous membrane, such as sneezing, lachrymation, photophobia. The flow is very variable, and seldom has any regularity either in the dripping or in the intermission; but the flow is seldom continuous for more than a few hours or a few days at a time. One patient informs me that she will be feeling quite well when suddenly she is seized with sneezing, and that before she can get out her handkerchief the fluid pours in a stream from her nose. At other times it comes in such a steady drip that she just places her handkerchief on her lap to catch it. Headache is not relieved by the flow, but is as a rule made worse. Cerebral symptoms are not marked. Ocular symptoms in connection with it are unknown, except for some conjunctival irritation.

Chemical Composition of Cerebro-spinal Fluid.

Finally, the chemical analysis may generally be relied upon to settle the diagnosis in all doubtful cases. In 8 out of the 9 cases in Group "A" this analysis is sufficiently complete; in the seventh case the post-mortem showed the origin of the fluid. Of the 12 cases in Group "B" we have an analysis of the liquid in 7 cases, and a study of the results therein given, when compared with the standard analysis of undoubted cases of pure nasal hydrorrhœa and of cerebro-spinal rhinorrhœa will suffice to show that in each of these 7 cases the chemical reactions point towards the cerebral source of the liquid. In the remaining cases the fluid was reported to be clear and limpid; and in 3 cases of Group B, as in my own, the secretion did not stiffen linen, but the handkerchiefs "dried soft," and could be used again if necessary.

At the period when several of the above cases were recorded it was taught by Hoppe-Seyler[1] that the normal cerebro-spinal fluid had no copper-reducing substance in it, and that this latter was not obtainable from the first puncture of spina bifida and hydrocephalus, but only from later punctures and from the fluid in cases of meningitis. Hence he thought that the presence of the reducing body was a sign of irritation and inflammation. This has all been proved to be incorrect, but it serves to show how inadequate the tests were at that date. The same reasons may account for the absence of sugar in the analyses in 4 cases (viz. XII, XVI, XVII, XIX). One of Priestley Smith's cases (XVIII), however, did show a reducing body with Fehling's solution.

The uncertain views still held with regard to the chemical composition of the cerebro-spinal fluid is shown by a recent paragraph in the 'Lancet' (November 6th, 1897, p. 1199). It is there stated that the investigations

[1] 'Physiol. Chemie,' Berlin, 1881, S. 605, 608.

of various chemists have been without satisfactory results, partly, perhaps, because the fluid has been examined not in healthy but in diseased conditions. The question at issue is further confused in this paragraph by a clerical error in attributing to Hammarsten ('Physiological Chemistry') the opinion that the body which reduces copper oxide is "fermentable," a statement that is not compatible with its being pyrocatechin. Prof. Halliburton found on communicating with Hammarsten that this was a misprint for "unfermentable." In the same paragraph the researches of Dr. E. Nawratzki, of the Dalldorf Asylum for the Insane, are quoted. He obtained cerebro-spinal fluid from the calf by means of lumbar puncture, and the results of his tests are in opposition to Hoppe-Seyler and others, for he finds that in health a substance is present which in all its properties agrees with grape-sugar, while pyrocatechin is entirely absent. It is possible that the sugar found by Nawratzki was obtained from the blood, admixture with which he admits while making the puncture. He states that the amount of sugar he obtained was less than that in the blood. If the reducing substance is all sugar it should be more abundant, the reducing substance in cerebro-spinal fluid being considerable; in fact, its presence is the most striking feature about cerebro-spinal fluid. There are other reasons, which need not be detailed here, for thinking that some serious errors must have crept into his experiments. My own case has happily afforded Professor Halliburton repeated opportunities of examining considerable quantities of human cerebro-spinal fluid, obtained in an almost absolutely pure condition, and his analyses have only confirmed one another in the results obtained. These results will form a standard of reference for the future, and help to reconcile the doubtful and conflicting analyses in the past. The chemical results of analysis in several of the cases in Group "B" need not therefore, by themselves, be looked upon as decisive as to the origin of the fluid.

Diagnosis from So-called Dropsy of the Antrum.

But if the bilateral character of the flow is the principal point in eliminating the possibility of the secretion in question being intra-nasal in origin, this objection does not hold in regard to the second chief argument which will be urged against my thesis; I mean the suggestion that the watery fluid is a dropsy of the antrum of Highmore, or of the frontal sinus. This, in fact, is the explanation which was given by Sir James Paget of the second case in this group, and it requires due consideration because, possibly without sufficiently careful study, his case has been quoted by many of the observers which have followed him, and it has evidently biassed their diagnosis.

The following would appear at first sight to be a well-authenticated case of one-sided nasal hydrorrhœa originating in the maxillary antrum.

A. R. Anderson (Nottingham).—"Nasal Hydrorrhœa," 'Lancet,' 1892, vol. i, p. 474. (Also reported in the 'Brit. Med. Journ.,' February 6th, 1892, p. 276.)

A young woman, aged 19, had for some time been troubled with a perfectly clear, watery discharge from the left nostril. The discharge was almost continuous, but could be increased by inclination of the head to the opposite side, and after a quantity had flowed forth in this way it would for a time cease. There was no symptom or sign of disease in either the ethmoidal, frontal, or sphenoidal sinuses, and no tumefaction of the cheek or other sign of distension of the antrum. Nothing could be discovered in the anterior or posterior nares. From the symptoms it appeared evident that the antrum furnished the discharge. The molar teeth on the affected side were carious, and the cavity was opened by extracting the second and peforating the bone, when a quantity of clear fluid similar to that discharged from the nose was evacuated. The cavity was drained into the mouth and douched daily with an astringent wash. This did not effect a cure, so the opening in the bone was enlarged to a sufficient extent to admit the end of the little finger,

when a number of minute polypi were found projecting from the mucous lining of the antrum. The interior was scraped with a director and swabbed out with a solution of chloride of zinc, which effected a cure in about six weeks. When last seen some months after, the patient was quite well, and had no recurrence of the symptoms. Allusion was made to a case very similar to the above in many respects which had been reported by Sir James Paget to the Clinical Society in 1878.

It is noteworthy that in the above, as in so many cases in Groups "A" and "B," the discharge was from the left side. As the cavity was drained into the mouth and yet the watery discharge from the nose did not cease, I think the case is quite open to the suggestion that it may have been one of cerebro-spinal rhinorrhœa, and that the polypoid degeneration of the lining of the antrum was a coincidence.

A secretion so watery and abundant as it was reported to be in most of the cases, is in all probability the product of a vascular organ especially adapted for secreting, such as the choroid plexus of the ventricles. Leber compares the secretion to that of the ciliary processes of the eye and the glomeruli of the kidney.

Serous Accumulation in the Maxillary Sinus.

Now there is a very strong *a priori* argument against the possibility of the mucous lining of the antrum being able to secrete mucus or watery fluid to any great extent. It is considerably thinner than the nasal mucosa; the mucous glands are much scantier,—Sappey,[1] indeed, only found some on the floor of the sinus. Zuckerkandl[2] says they are distributed on all the walls, but that they are neither so regular nor so numerous as in the mucous membrane of the nose. In any case there are no vascular arrangements like the erectile tissue in the nose, for

[1] 'Traité d'Anatomie,' tome ii, 2e partie, 2e fasc., p. 744.

[2] 'Anatomie normale et pathologique des Fosses Nasales,' traduit en Français, 1895, tome i, p. 310.

the secretion of a large amount of watery fluid. In catarrh of the maxillary sinus the mucus secreted amounts to very little, and is only established when hyperæmia exists for some time. "Then," says Zuckerkandl, "exudation chiefly takes place in the substance of the lining membrane of the antrum. It is not only the mucosa, but rather the deeper layers of the membrane which serve the function of periosteum, which present this infiltration of the structure; the swollen membrane, when the affection is intense, attains to ten or fifteen times its original thickness; it is infiltrated with serum, œdematous, jelly-like, and its free surface is dotted with bulgings of a clear yellowish white, filled with liquid. The glands at the same time undergo cystic degeneration. When the whole mucous lining presents this degeneration the sinus appears as if affected with dropsy. As a rule the lumen of the sinus is simply narrowed, according to the amount of swelling of the mucosa; it contains, along with air, a greater or less quantity of liquid mucus."

But Giraldès[1] gives a very similar account of the structure of the mucous lining of the antrum. With regard to the mucous cysts, he had found as many as twenty in one specimen, and sometimes bigger than a pigeon's egg.

He quotes Goubaux to the effect that these tumours are common in cows. It would be interesting to know if these animals are subject to nasal hydrorrhœa. The walls of these cysts are thin, and the contents vary. As a rule it is a viscous liquid, thick, stringy, transparent, and sometimes yellowish. In other cases it is opaque and even caseous. In larger cysts it is more liquid, yellowish white, sometimes transparent and syrupy in consistence, or stringy, like white of egg. But the important point of Giraldès' observations is the statement that he is not aware of a single autopsy where the liquid has been found free in the sinus, and so offered any analogy to the dropsy described by some authors. Indeed, he challenges the production of a single post-mortem demonstrating the

1 'Recherches sur les Kystes muqueux du Sinus maxillaire,' Paris, 1860.

presence in the cavity of the sinus of this so-called dropsy.

Evidently the contents of these cysts bears no resemblance to the watery fluid which escapes from the nose; and any free secretion which their presence may excite in the cavity is much too slight even to amount to a dripping from the nares. That would presuppose that the sinus was completely filled—the orifice being on an upper plane—and constantly replenished.

In a discussion on this subject at the Société de Chirurgie [1] MM. Berger and Magitot said that dropsy of the antrum was a condition they had never met with, and one of which they positively contested the existence. The so-called retention cysts of this cavity should also be relegated to the legends of last century, always excepting the cysts (so-called "cysts of Giraldès") which are developed in the mucous glands of the walls of the sinus.

In spite of the pathological objections of Giraldès, Luschka (1855),[2] Virchow (1863),[3] Zuckerkandl (1882),[4] Heymann (1892),[5] and Dmochowski (1895),[6] the current literature of diseases of the upper air-passages continues to have references to what are termed "mucoceles" of the accessory sinuses, with suggestions of symptoms of cases somewhat like those in my second group. Under the heading of "Mucocele," Jonathan Wright, who has done most valuable work in the pathology of diseases of the nose, thus refers to the matter in a recent publication: [7]

[1] 'Bulletin et Mémoires,' tome xiv, 1888, Séances du 28 mars et du 11 avril.

[2] Luschka, "Die Schleimpolypen der Oberkieferhöhle," 'Virch. Arch.,' Bd. viii, S. 419.

[3] Virchow, 'Die krankhaften Geschwültse,' Bd. i, S. 245.

[4] Zuckerkandl (loc. cit.).

[5] Heymann, "Ueber gutartige Geschwülste der Highmorshöhle," 'Virch. Arch.,' Bd. cxxix, S. 214.

[6] Dmochowski, "Beitrag zur patholog. Anatomie und Actiologie der enzündlichen Processe im Antrum Highmori," 'Archiv für Laryngol.,' Bd. iii, S. 284.

[7] 'Twentieth Century Practice,' vol. vi, 1896, p. 93.

"Cases have been reported from time to time of serous accumulations in the antrum of Highmore. Their pathology is not understood. The symptoms they present are very indefinite, being chiefly sensations of pain and heaviness in the head and the ordinary symptoms of chronic rhinitis. There is an intermittent watery discharge from the nose. Occasionally the watery discharge is more or less constant. This symptom, as, indeed, also the pain, apparently depends upon the degree of permeability of the ostium maxillare. A satisfactory diagnosis can be made only by puncture with the trocar and cannula. . . . These cases seem to be, at least in this country, of very rare occurrence."

With regard to the frontal sinus he remarks (p. 99), "Accumulations of serum and of mucus in the frontal sinus have been frequently reported. . . . There may be a continuous or an intermittent discharge of clear fluid or of mucus from the nose, or there may be no such discharge, but distension of the inferior walls of the sinus."

Noltenius[1] reports thirty-seven cases in which, by exploratory aspiration, he found serous exudation in the maxillary sinus, the liquid being clear and slightly amber-coloured; in two cases it held in suspension little flakes. The principal symptoms are supra-orbital neuralgia, nasal obstruction without any hypertrophy to explain it, and much more rarely attacks of nasal hydrorrhœa.

But Alexander[2] points out that the exploratory puncture of the maxillary sinus and withdrawal of serous fluid is no diagnostic proof of a retention dropsy of the antrum, for the serous fluid might have been contained in the cysts or extravasated in the antral cavity after the collapse of the cyst walls. Although he grants that serous exudation in the cavity is theoretically possible, he asserts that absolute proof of such a condition is not forthcoming. The challenge made by Giraldès in 1860 still remains unanswered. Alexander examined seven cases with polypoid degeneration of the mucous lining of the antrum. There was some hypersecretion, but no nasal hydrorrhœa in any of them. He found the contents of the cysts to

[1] 'Monatsh. f. Ohrenh.,' April, 1895, p. 114; from ref. in 'Annal. des Mal. de l'Oreille.'

[2] 'Archiv für Laryngologie,' Bd. vi, 1897, Heft 1, S. 130.

be a greenish-yellow serous fluid, which, on standing, stiffened to a gelatinous mass, and on boiling solidified completely. The chemical analysis he made gave the following result:

Water	91·2.
Dry residue	8·5 (7·4 being albumin).
Ash	0·3.

Affections of the frontal sinus so frequently lead to displacement of the eye that we have to seek in ophthalmic literature for illustrative cases affecting this sinus. Silcock[1] explains distension of the frontal sinus as being due to the retention of the mucous secretion of the cavity from temporary or permanent blocking of the infundibulum. He considers that empyema of the frontal sinus is not so often met with as simple retained mucus distension. In the cases he records he found within the sinus "thick, greenish, tenacious stuff, very like half-melted size, or partly decolourised bird-lime;" the mucous membrane was hypertrophied, and in one instance he found polypi.

But the record of the "tenacious stuff, very like half-melted size," and the description of the condition of the mucous membrane, are very suggestive of the pathological condition of cystic degeneration described by Giraldès and Zuckerkandl. There is no record of rhinorrhœa in any of Mr. Silcock's cases, although one had previously had a discharge from his nostrils, copious in cold weather. When examined, this was found to be mucopus.

Cresswell Baber and Bond[2] have published cases of what are termed "mucocele" of the frontal sinus. In both cases the collection of clear viscid mucus which was discovered in the cavity was attributed to the obstruction of the fronto-nasal duct. In neither case was there any watery discharge from the nose.

[1] The 'Practitioner,' 1897, vol. i, p. 244.

[2] 'Proceed. Laryngol. Soc. Lond.,' vol. iv, 1896–7.

Diagnosis from Water inspired and retained.

Still another possible source of origin of the watery flow from one side of the nose has been suggested by Lingard,[1] who thinks that in the following case the water used for washing was drawn up by the patient into the accessory sinuses of the nose, from which it trickled out when he bent his head forwards.

A gentleman aged 26 had suffered great inconvenience for nine months from a watery discharge from his right nostril, which came on at intervals during the day, also right frontal headache. With the exception of a fall from a height of forty-five feet on his right forehead fifteen years previously, nothing was found to account for the symptom. The author was inclined to refer it to this cause, and supposed that some fracture of the cribriform plate of the ethmoid might possibly have taken place and allowed the escape of the cerebro-spinal fluid. The patient could not suggest any other cause for its occurrence, and had never suffered either from polypus or syphilis. It was observed that the flow depended wholly on the position of the head. Totally absent when on his back or in the upright position, it invariably occurred on bending forward the head,—as, for example, in reading or writing, which was annoying, as a few drops of straw-coloured fluid would fall on his books or papers. It was by accident that the author found out the real cause. On visiting his patient earlier than usual one morning he surprised him with his face in a basin of water, which he alternately drew up and expelled from his nose, with a view "to clearing out his head," as he thought. He was desired to desist from this, by way of experiment, for a few days. The discharge then ceased and has never recurred.

That the discharge was simply the return of the indrawn water appears to me to be extremely open to doubt. The capacity of the sinus is limited. It is inconceivable that the inspiratory suction of the water in the basin would draw it into the accessory cavities; and it is difficult to understand how the fluid would take such a circuitous direction instead of following the direct channel into the pharynx. That the flow should be

[1] 'Brit. Med. Journ.,' 1878, vol. ii, p. 921.

entirely absent when the patient was on his back is not in favour of its originating in the antrum, for in the horizontal position the mouth of the cavity is on a much lower level than it is when the head is simply bent forward. Indeed, such a variety in the flow is much more compatible with the clinical pictures which have preceded on the escape of cerebro-spinal fluid; the one-sided watery discharge, increased by bending forward and ceasing in the upright and horizontal posture (? flow into throat), the headache, the apparent absence of intra-nasal changes, and of such symptoms as lachrymation, sneezing, &c., are all compatible with the hypothesis that the fluid may have been of intra-cranial origin.

Diagnosis from Vaso-motor Neuritis.

In his cases of nasal hydrorrhœa Bosworth includes a reference to the case published by Althaus in the 'Medico-Chirurgical Transactions,' 1869, vol. lii, p. 27. The hypersecretion of liquid in this case was attributed by the author to the removal of the inhibitory influence of the trifacial, so as to allow the sympathetic fibres to reign supreme. The hypersecretion occurred not only in the nose, but also in the eye and mouth. In the 'British Medical Journal' for December 7th, 1878, Althaus suggests that Sir James Paget's case was probably one of injury or inflammation of the nasal twig of the ophthalmic branch of the fifth nerve, and that the "headache" from which the patient suffered shortly before the flow commenced was a symptom of neuritis of that twig.

Diagnosis from Ruptured Lymph Tubes.

Are there any other possible suggestions which might be entertained as to the origin of this fluid? The idea

was put forward by Mules, writing in 1888, that the dropping from the nose in some of these cases was due to the rupture of over-distended lymph tubes in the pituitary membrane.

MULES (Manchester).—"Lymph Nævus and other Lymphatic Derangements of the Eye and its Appendages," 'Siebenter periodischer Internationaler Ophthalmologen-Congress,' Heidelberg, 1888. Bericht, S. 467.

The writer holds that the association of persistent dropping of fluid from the nostril with cerebral symptoms and optic nerve atrophy is only accidental, and that the symptoms are in no way interdependent. He narrates the following case:—A bright, intelligent girl of eleven attended the Women's Hospital, Manchester, for a copious discharge of fluid from the umbilicus, of six months' continuance, no visible fistula being present. Besides this, for the last four weeks, fluid apparently identical with that from the umbilicus had dropped from under the upper right lid. It was found that at frequent but irregular intervals during the day and night a fluid bearing all the physical characters of lymph oozed from under the upper eyelid in the region of the lachrymal gland, yet no care could detect its exact point of exit. The fluid was opalescent though faintly muddy, and whilst usually dropping quickly, occasionally ran in a stream. The amount lost in twenty-four hours was variable, but may be estimated at from four to six ounces or even more, the quantity depending much on the discharge from the umbilicus. Lachyrmal stimulation failed to induce or increase the flow. Dr. MacMunn, of Wolverhampton, reported that "it agrees in all essentials with Priestley Smith's two recorded cases Emrys-Jones' case, and those mentioned by Leber." The specific gravity was 1·006. The patient had normal vision with corrected astigmatism; no head symptoms; the discharge still persists.

He further describes a case of "congenital lympho-angioma of the conjunctiva and brow" in a boy of 12, and that of an elderly unmarried lady who complained of increasing weakness of sight, and who was markedly emaciated. For three years she had suffered from continuous diarrhœa; she had had a prolapsed rectum three months after the diarrhœa commenced. For three years her diarrhœa had alternated with a watery discharge from the bowel, necessitating the use of five or six diapers daily. "There was found just inside the sphincter a pale pink lympho-angioma, the size of a small walnut, with several minute fistulous openings, from which trickled a clear

presumably pure lymph. The growth was ligatured, and with its removal the diarrhœa ceased and she rapidly recovered flesh, but unfortunately with her, as is the case of those with dropping from the nostril, with sudden arrest of the lymph-waste came alteration of the vascular balance, and six weeks after the removal of the nævus an apoplectic attack occurred with permanent paresis of the left side." He also suggests that the hypothesis of a lymph extravasation will explain many cases of sudden proptosis which appear and pass away without apparent cause. He thinks that even the proptosis of exophthalmic goitre may be due to a lymph congestion amounting almost to stasis of the orbital lymph stream, the outcome of vaso-motor paresis. He therefore concludes "that these taken together show that the nasal flow, over the source of which so much debate has arisen, may be definitely considered to be a lymphorrhœa, due to over-distended lymph-tubes of the pituitary membrane, which by their bursting caused fistulous openings, the difficulty of finding them post mortem being due to the fact that they collapse, and the number of the valves precludes their demonstration by injection.' He says that in the case of the girl "we know that the escaping fluid is lymph, identical in character with the nasal dropping of the other reputed cases, and the cerebro-spinal fluid." He is brought to the conclusion "that hydrocephalus and polypi are accidental associations of this lymphorrhœa; that the nerve atrophy is an incident rather than a necessity."

Qualitative Examination of Mules' Case of Persistent Dropping Fluid from the Orbit. By Dr. MacMunn.

Sp. gr. 1006.
Opalescent with heat and acetic acid.
Opalescent with heat and nitric acid.
Violet when boiled with Fehling (albumen).
Chlorides abundant.
Sulphates present.

Spectroscopically no bands except faint traces of oxyhæmoglobin due to accidental presence of blood and traces of sero-lutein.

Note A.—The absence of sugar in these cases has been made a point, but according to Hoppe-Seyler sugar is not a normal constituent of cerebro-spinal fluid, but is due to irritation of the brain or cord.

Note B.—Exception may be taken by some to the inclusion of cerebro-spinal fluid under the term "lymph." By lymph we understand the fluid contained in the lymphatic vessels as well as the liquid found in the extra-vascular spaces, such as the lacunæ of connective tissue or the interior of the great serous sacs, from which the lymphatics originate or communicate.

Inasmuch as divers organs possess different separative power, so lymph varies materially in composition, according to the region from which it is derived; thus while lymph coagulates, as a rule, into a soft, trembling jelly, Ludwig (quoted by Gorup, Besanez's 'Lehrbuch,' p. 378; *vide* Gamgee, 'Physiological Chemistry,' p. 220) points out what some of the above cases fully substantiate, that "some lymph does not coagulate at all," but is identical in appearance and composition with cerebro-spinal fluid, the fibrin or coagulating substance being due to its further elaboration in the glands.

Difference between Lymph and Cerebro-spinal Fluid.

The above suggestion of Mules may have been worthy of consideration at the date it was written (1888), but the further progress of the chemistry of the cerebro-spinal fluid—for which we are chiefly indebted to Halliburton—has rendered it untenable.

In his well-known text-book[1] Halliburton points out that the cerebro-spinal fluid is not a serous exudation, because (1) the arachnoid membrane is not a serous membrane, either from the point of view of embryology or structure; (2) the fluid is not a mere lymph moistening the parts already enumerated, but is normally present in sufficient quantity to exercise a considerable amount of pressure; (3) chemical examination of the fluid itself shows that it is very different from the fluids contained in serous membranes, and thus support is lent to the idea originally propounded by C. Schmidt, that the fluid should be classified rather with secretions than with transudations.

On the other hand, lymph is an exudation; it is like blood-plasma in composition, only diluted so far as its proteid constituents are concerned. There is no doubt as to the presence of albumin in it; it coagulates spontaneously, and the specific gravity varies from 1012 to 1022. It always gives all the tests for sugar. And in human lymph the total proteids amount to 13·66 per

1 'A Text-book of Chemical Physiology and Pathology,' by W. D. Halliburton, London, 1891, p. 355.

1000, *i. e.* about ten times the amount we find in Leber's analysis.

Though the cerebro-spinal fluid is not lymph in the chemical sense of the term, there is, however, no doubt that its function is to serve as the lymph of the central nervous system.

Some of the confusion in the above analyses may be due to the accidental admixture with blood, which is mentioned in some instances.

Summary of Evidence in Support of the Cases in Group "B."

The eight cases I have placed together in Group "A" are undoubtedly instances of cerebro-spinal rhinorrhœa; they leave no room for question, and need not therefore be further discussed. With regard to the twelve cases in Group "B" I have eliminated the possibility of suggesting that the flow originated from the Schneiderian membrane, the lining of the accessory sinuses, or the rupture of distended lymph-tubes. These considerations have helped to narrow considerably the field of diagnosis, but some positive indications will now be grouped together to support the view that in all of them the source of the fluid was the subdural and subarachnoid cavities.

In eleven out of these twelve cases the fluid escaped in considerable quantity. The amounts in the different cases show a remarkable correspondence when we consider that in the well-ascertained cases of Group "A" the rate of flow was subject to some variation. Roughly estimated, the maximum discharge in the twenty-four hours may be placed on the average at half a litre (about 18 ounces). When carefully measured, as in Case XVII, it is striking that the quantity should so nearly approach that of my own case (Case VII). The amounts given by King (Case X) of a quart, and by Elliotson (Case XI) of three

quarts per day, appear to be based on uncertain calculations.

In eight instances it is mentioned that the flow was one-sided, five times coming from the left and three times from the right. Twice it alternated; once it was more from the left than from the right; and once no mention is made of the side most affected. In this preference for the left side the majority of cases in Group "B" agree with the positive cases of Group "A."

In five cases the flow continued by night as well as by day. In only two cases is it recorded that the escape of the fluid was not noticed at night. In five instances there is no note on the subject, but doubtless if more carefully observed it would have been discovered that in sleep the liquid passed into the pharynx and was swallowed unconsciously.

In four of the cases (XV, XVI, XVII, and XVIII) there a remarkable similarity in the group of symptoms: persistent dropping of a watery fluid from the nose, together with long-continued severe brain symptoms,—such as violent pains in the head, epileptic attacks, vomiting, drowsiness, delirium, unconsciousness, weakness of the legs, and extreme impairment of vision in both eyes owing to optic neuritis or post-neuritic atrophy. This clinical picture at once recalls Leber's case (II, A), which was undoubtedly one of cerebro-spinal rhinorrhœa. In four cases it is noted that the loss of vision was most marked in the eye on the side corresponding to the nasal flow.

Nine out of the twelve cases suffered from symptoms referable to the brain, varying from headache up to giddiness, somnolence, vomiting, paralysis, convulsions, and coma.

In each of the three fatal cases, as in the fatal cases of Group "A," death was due to cerebral causes. Case XII, B, has been so frequently referred to in literature as a typical one of watery nasal discharge caused by polypi in the antrum, and the high authority of Sir

James Paget has evidently biassed observers so remarkably towards the same view, that a somewhat fuller consideration of his case appears needful. It is noteworthy that the dropping was preceded by severe headache; that the flow was generally fairly uniform and continuous day and night; and that twice it ceased spontaneously, but otherwise had shown no intermission during eighteen months. In all these points it markedly resembles the cases where the fluid came from the cranial cavity. The question of its being from the antrum of Highmore has already been so fully considered, that it need only be pointed out that the fluid "was like pure water, or the fluid of the pia mater, or that of an acephalocyst:" the solid matters present were evidently accidental; and the physical aspect of the liquid—apart from the chemical analysis—was much more indicative of the fluid being produced by some secretory arrangement more highly organised than the mucous lining of the maxillary sinus. Laying aside for a moment the clinical and chemical considerations, there is another point which weighs against the suggestion that the rhinorrhœa was brought about by the polypi in the antrum. This point is that as polypoid degeneration of the lining of the maxillary sinus is of frequent occurrence, it is remarkable that watery flow from the nose is not more common. Besides, if the fluid came from this cavity, why should it cease for the month before the fatal attack? The polypi, as evidenced by the post-mortem, were still present to cause it. Finally, the fatal meningitis, which could have no relation to the polypi in the antrum, becomes explicable as the evidence points more strongly to the source of the fluid in the cranial cavity. This view need not be abandoned because no opening was found in the base of the skull, for in Case VI, "A," where there was an undoubted solution of continuity in the base of the skull, the opening is reported to have been "hardly perceptible." It is pointed out by Leber[1] that we can imagine how small

[1] Loc. cit.

such communications may be when we remember that in cases of pulsating exophthalmos it is generally impossible with the most careful post-mortem examinations to detect the true cause of this condition, viz. an abnormal communication between the internal carotid and the cavernous sinus. Nor need we abandon this view because the dura mater covering the anterior fossa was healthy. Our experience with secondary complications from diseases of the middle ear frequently show that infection may be carried to a distance while the intervening tract is, to the naked eye, perfectly healthy.

With regard to cerebral infections from the eye, Devereux Marshall[1] records two cases of meningitis following excision of the eyeball for panophthalmitis which show that the proximal region of the brain is not always the part most invaded. In one case he says "there was no basal meningitis," and in the other "there was hardly any meningitis seen at the base of the brain, but it was most extensive in the convex surfaces of both hemispheres."

Several of these same conclusions may be advanced with regard to the autopsy in Baxter's case (XV, B).

In the case of Speirs (XIV, B) the symptoms are all so indicative of cerebro-spinal rhinorrhœa that it is sufficient to direct attention to the description of them. The suggestion that the goose-grease may have filled up the communication between the nose and the antrum, leading to such alteration in the lining of the latter cavity as to effect a cessation of the excessive secretion, hardly calls for consideration. In this, as in several other instances, it is necessary to bear in mind that the bibliography of the subject is now sufficient to show that spontaneous cessation of the flow takes place at the most unexpected times and for no apparent reason.

Although some of the symptoms in Lichtwitz's case (XXI, B) were suggestive of ordinary nasal hydrorrhœa,

[1] The 'Roy. Lond. Ophth. Hosp. Repts.,' December, 1896, p. 312, Cases II and IV.

still one profuse watery flow (entirely from one nostril) was unattended by headache or lachrymation. It is extremely rare for vaso-motor rhinitis to be limited to one side : it is inconceivable, as has been shown, that the frontal sinus of one side could secrete such enormous quantities of fluid ; and it is to be particularly noted that the tappings of the sinus did not evacuate any clear fluid. The flow was evidently as profuse as ever after the puncture of the sinus, and as the permanent arrest of the secretion only took place one year subsequently, it can hardly be attributed to the treatment of the frontal cavity. On the other hand, the diagnosis of cerebro-spinal rhinorrhœa appears to me much more likely for the following reasons : pains in the head ; ocular trouble ; one-sidedness and great profusion of discharge ; persistence during the night ; the liquid being clear as water, and not stiffening linen.

Clinical Picture.

Granting that the twelve cases collected under Table "B" were instances of cerebro-spinal rhinorrhœa, and placing them alongside of my own and the other eight undoubted cases in Table "A," what is the clinical picture formed by comparing and contrasting the several records ? The first point is that the sub-arachnoid fluid can escape through the nose, without trauma or new growth to explain how it effects an exit. This occurrence happens with equal frequency in both sexes. It is an affection of middle life, the age incidence falling between the extremes of eighteen and sixty-five. The flow, in most cases, commences gradually ; it occurs in drops, much as the flow of blood in epistaxis ; and in carefully recorded cases it is continuous both by day and by night ; in the latter period it may be swallowed during sleep. It generally makes its escape from one nostril only, but may flow from both. The fluid which escapes amounts

to about half a litre in twenty-four hours; it is as clear and limpid as spring water, perfectly free from odour, and tasteless, or only slightly salt. The quantity which may escape in one day is, in itself, no positive evidence of a nasal flux being cerebro-spinal in origin; for Bosworth reckons that in one of his cases, apparently one of true hydrorrhœa nasalis, the secretion amounted to a pint in the day. The quantity of cerebro-spinal fluid is increased when the patient strains in any way, or hangs the head forward; it is said to be increased during a cold, but this is probably only due to the admixture of ordinary mucus. If collected with care the fluid is found to be absolutely sterile. A superficial examination would show that it is faintly alkaline, with a specific gravity of 1005, that it gives a slight opalescence on boiling, that it reduces Fehling's solution, but the fermentation test proves that this is not due to sugar.

The following is a list of the reactions which determine the cerebro-spinal character of the fluid.

Chemical Tests for Cerebro-spinal Fluid.

1. The fluid is perfectly transparent like water, and contains no sediment.
2. It is faintly alkaline in reaction, and either tasteless or slightly salt.
3. The specific gravity is between 1005 and 1010.
4. It is not viscous, and gives no precipitate (mucin) on adding acetic acid.
5. On boiling there is not more than a trace of coagulum of serum globulin. Serum albumin is usually absent, for after saturating with magnesium sulphate and filtering off the precipitated globulin, no proteid is found in the filtrate.
6. When boiled with Fehling's solution reduction takes place.

7. The reducing substance may be obtained by evaporating to dryness an alcoholic extract of the fluid. It is then found in the form of needle-like crystals (*vide* Plate, p. 19).

8. The aqueous solution of this residue does not ferment with yeast, and does nor give the phenyl-hydrazine reaction.[1]

These tests are quite sufficient to show that the reducing substance is not sugar. Although its exact composition is still unsettled, it is possibly related to pyrocatechin.

If applied to suspected cases, these tests will, in future, avoid any question as to the true nature of cerebro-spinal fluid when it escapes from the nose. Confusion and uncertainty may have been brought about, in the past, by observers basing their knowledge on the character of this fluid in diseased conditions. For instance, in hydrocephalus, especially if there is any inflammation, the specific gravity is higher, and the amount of albuminous matter greater. In general paralysis of the insane there is no reducing substance, but a large increase of proteid or albuminous matter, and a substance alkaloidal in nature (choline from the degenerated brain-cells), which markedly reduces blood-pressure (Mott and Halliburton[2]).

These cases confirm the opinion of Magendie that cerebro-spinal fluid is reproduced with great rapidity. This is interesting in view of Foster's statement that "the quantity present in the subarachnoid space of the cranial cavity is small, probably not exceeding 2 c.c. under normal circumstances; there is a larger quantity in the spinal canal."[3] Leonard Hill[4] found experimentally that removal of the cerebro-spinal gives place

[1] The phenyl-hydrazine test consists in boiling a suspected liquid for half an hour with small quantities of phenyl-hydrazine hydrochloride, and sodium acetate. If sugar is present, yellow crystals of osazone are formed.

[2] 'Proceeds. Physiol. Soc.,' February, 1897, and February, 1898.

[3] 'Text-book of Physiology,' 7th edit., 1897.

[4] 'The Physiology and Pathology of the Cerebral Circulation,' London, 1896

to a serous transudation, and Foster [1] is of opinion that when the fluid is quickly formed its peculiarities disappear, and it then acquires the characters of an ordinary serous exudation. It does not appear to be so in my case, so that the conclusion is suggested that in the present instance the secretion takes place under peculiar conditions.

These cases also show that a draining away of this fluid may continue during several years, without exerting the slightest appreciable effect on the functions of the central nervous system. *Inter alia* it may be noted that the perilymph and endolymph apparently must be kept at a certain tension for the proper performance of their conducting function. Now the cavity which contains the perilymph communicates through the sheath of the auditory nerve with both the subdural and subarachnoid spaces.[2] In none of the above twenty-one cases do aural troubles seem to have been induced by alterations of tension in the labyrinth consequent on this nasal flow.

Of seventeen cases where it has been carefully observed which nostril was affected, it has been noted in ten that the escape took place entirely from the left side. What is the significance of this apparent preference for the left side? Does it depend on the same causes which lead to the rare condition of unilateral destruction of the olfactory bulb with anosmia? In these the left bulb has always been the one affected. ('System of Medicine,' edited by Clifford Allbutt, 1898, vol. iv, p. 695.) But yet the fluid may escape from both nostrils (Case VI), although the communication with the cranial cavity only existed on one side.

Examination of the interior of the affected nostril reveals nothing more than slight excoriation of the naris, and some intumescence of the middle turbinal. If the escape is carefully watched it is found to take place

[1] 'Text-book of Physiology,' 7th edit., 1897.

[2] 'Quain's Anatomy,' 10th edit., 1894, vol. iii, pt. iii, p. 104.

between the middle turbinal and the septum, and therefore from a higher region than the openings of the maxillary or frontal sinuses and the anterior ethmoidal cells. Of course this cerebro-spinal rhinorrhœa may occur when other conditions are present in the nose or its accessory cavities, and the consequent complication of symptoms should be borne in mind. The long-continued soaking of the mucous membrane in fluid may conduce to the secondary formation of mucous polypi.

From other discharges from the nose, cerebro-spinal fluid can be distinguished not only by the physical and chemical characters already given, but also by the manner of its flow. It is generally one-sided. Although it may occasionally give rise to a little sneezing, especially in the morning or on changing position, this is a rare and infrequent accompaniment. It is not accompanied with lachrymation, or suffusion of the conjunctiva and photophobia. Although it rarely intermits, it is practically a continuous flow, varying slightly in amount under the influence of straining and posture. It appears to be uninfluenced by external conditions or by the general state of health. In these several points it contrasts markedly with hay fever, paroxysmal sneezing, vaso-motor rhinitis, &c.

Most of these latter affections are also accompanied with more or less prostration and lassitude, the patient always feeling worse when the flow is taking place, and experiencing relief only when it ceases. It is a curious and noteworthy fact that in a large number of instances of cerebro-spinal rhinorrhœa cerebral symptoms are present, but they precede the flow, and are, as a rule, remarkable by their cessation while the fluid is escaping. The headache which in some cases was present before the onset of the flow, nearly always recurs when the flow diminishes or intermits.

It is important to bear in mind that the flow may spontaneously cease for periods varying from a few hours to several months. In some cases it has spontaneously

ceased altogether, or at least it had not recurred after an intermission of five or even fourteen years. Such cessations of the flow must be watched with suspicion, for recurrence has taken place even after an intermission of fourteen years.

These cessations are numerous enough to make us chary in attributing a cure to any form of treatment we may be employing.

A certain number of these cases are associated with ocular affections. In some instances (6) affections of sight are complained of before any dropping from the nose appears, but in others (2) the dropping has been going on for some time before the eyes become affected. The ocular lesion generally takes the form of retinitis and optic nerve atrophy.

This *bizarre* affection has been known to endure for five years in a well-authenticated instance (Case VII A), and for twelve years in a possible case (Case XIX B). The cerebral symptoms which have been associated with the flow are also remarkable for their occurrence in connection with the fatal termination of some of the cases. In the cases where there is a record of the fatal termination —in six out of twenty-one cases—it was in every instance due to cerebral complications—although we must observe that in one case (VI B) this was undoubtedly connected with surgical interference.

The post-mortem in this case showed that the escape in life had taken place through a small hole in the dura mater, alongside the apophysis crista galli. Of the other instance where death took place with cerebral symptoms, we have only the statement of the fact in two cases; in two other cases, although gross lesions were found in the brain and membranes, no connection could be found with the nose, and in another case the result of the post-mortem examination was entirely negative. Possibly it may have been overlooked in these last three cases, for the cerebro-spinal origin of the fluid had not been diagnosed in either of them, and in the above case (VI A), where the communication

between the cranium and nose was found, it is reported to have been "hardly pereeptible." There are no records of death from any other complieations.

Pathology.

Leber regarded his case (II) as undoubtedly one of hydrocephalus internus, in which the ossification of the skull lead to inereased intra-cranial pressure. The other six eases to whieh he was able to refer (Cases XI, XII, XV, XVI, XVII, XVIII) at the date of his publieation (1883) he ascribes to a late hydroeephalus, although he allowed there was no direet evidenee of this. But he reeords the case of a young woman where von Graefe made the diagnosis of a neuritis descendens consequent on a meningitis of the base of the skull. There was no question of hydrocephalus during life, and the post-mortem revealed no traee of meningitis or tumour, but, instead, a high degree of hydroeephalus with marked flattening of the eorpora quadrigemina and simple atrophy of the optic nerves. He also refers to a patient of Forster's[1] who suffered from attacks of giddiness, eonvulsions, and vomiting, and gradually became blind, where the post-mortem examination showed eonsiderable dropsy of the lateral ventricles and sueh a decided expansion of the middle ventriele that its floor projected like a bladder from the base of the brain so that the optic tract and ehiasma were quite flattened out. Such cases, he writes, may be amongst those where meningitis is sometimes suspected, but reeovery takes place. When such attacks recur we suspect the existence of a eerebral tumour, though this suspicion is abandoned when blindness continues for years with tolerably good health. Other factors which point towards hydrocephalus, and away from tumour, are the long duration of the

[1] "Zur Pathologie des Gehirns," 'Virchow's Archiv,' Bd. xiii, 1858.

illness in most cases, and the constant absence of symptoms pointing to one locality.

It is mentioned by Sir Thomas Watson[1] that hydrocephalus does occasionally commence long after the skull has become a complete case of bone. He quotes several cases, and amongst others that of Dean Swift, who is said to have died of this complaint in 1745, after an illness of three years' duration.

The hydrocephalus of adult life, or chronic meningo-ependymitis, is referred to in the last edition of Hilton Fagge's and Pye-Smith's 'Principles and Practice of Medicine,' vol. i, 1891, p. 672. Several cases are given, in all of which the ventricles were dilated with fluid; but it is said that the membranes at the base were frequently found thickened, opaque, and matted together, even more so in the affection of adults than in that of children. This does not agree with the description given by Quincke; and although in some cases the bilateral symptoms might suggest the nature of the disease, still hemiplegia was occasionally present and made the diagnosis from other chronic cerebral diseases exceedingly difficult if not impossible. Huguenin's attempt to give a systematic account of the disease affords additional proof of the variety of aspects that it may assume.[2]

Dercum[3] gives a very short notice of this affection, and states that there is nothing sufficiently characteristic in the symptoms to enable one to form a positive diagnosis. He says the presence of the disease may be surmised, but not determined.

Several cases of serous meningitis, or primary idiopathic hydrocephalus, have been reported by different writers (Eichorst, Oppenheim, Annuske), but for our clinical knowledge we are chiefly indebted to Quincke.[4]

[1] 'The Principles and Practice of Physic,' 4th edit., London, vol. i, 1857, p. 464.

[2] 'Ziemssen's Handbuch der Krankheiten des Nervensystems,' Leipzig, 1876.

[3] 'Text-book of Nervous Diseases,' 1895.

[4] 'Volkmann's Sammlung,' 1893, No. 67, and 'Deuts. Zeitsch. f. Nervenheilkunde,' 1896, ix, p. 149.

In Oppenheim's text-book there is a clear account of the affection, but the references to it in English literature are so brief and insufficient that the following sketch of the disease, in so far as the symptoms bear on the question under discussion, is taken from Quincke's articles.[1]

This description may be a little beside the main question I am concerned with, but still it deals with a condition which, I think, is sure to suggest itself in connection with the pathology of cerebro-spinal rhinorrhœa.

Hydrocephalus Internus.

The central idea of the disease is that we may have a serous as well as a purulent meningitis. Hitherto it has been customary to recognise only meningitis in a purulent form; but Quincke holds that a meningitis, particularly an ependymitis, may give rise to a simple serous effusion, as well as a purulent one; in this way meningitis becomes analogous, in its two forms, to the inflammations of other membranes—the pleura, pericardium, and synovial membranes. As such a meningitis may occur at all ages, and give rise to collections of fluid in the ventricles, we may have a primary idiopathic internal hydrocephalus of adults, as well as the classical form of children. The disease may be either acute or chronic; the acute cases are frequently mistaken for purulent meningitis, and the chronic ones for cerebral tumour. In another variety of the chronic form, according to Quincke, the symptoms are those of neurasthenia. The conclusive proof of an autopsy is necessarily lacking in the neurasthenic form, and even when at the autopsy an effusion is found, it is not customarily regarded as pathologically a sufficient cause of the symptoms or of death.

The acute form may run a rapid course throughout; or

[1] For several of these references I am indebted to an article by Morton Prince on "Idiopathic Internal Hydrocephalus (Serous Meningitis) in the Adult," with reports of three cases, in 'The Journal of Nervous and Mental Disease,' vol. xxiv, August, 1897, No. 8, p. 473.

after a course of some weeks it may end in complete or incomplete recovery or death, or become chronic. The chronic form may pursue a varying course, with occasional acute exacerbations. In both classes a remaining optic atrophy may be the sole indication of past cerebral disease.

The symptoms, as in other brain affections, are general and local, and depend largely upon increase of pressure. The local symptoms are paralysis (especially of the cranial nerves), exophthalmos, cervical pain and rigidity, hyperæsthesia, pain in the extremities, &c. It is by its course, and greater or less intensity of individual symptoms, that it is to be distinguished from other forms of meningitis and tumour. Fever is either absent or only slight, of short duration, and irregular course. The headache is diffuse or located in the forehead or occiput, of varying intensity, and sometimes periodic, or with periodic exacerbations. The headache may be associated with unrest, delirium, or sleeplessness. It is only in fatal cases that dulness of consciousness becomes continuous and profound. Vomiting is common. Rigidity of the neck, with tenderness and pain on motion, may be prominent. Paralysis of the ocular and facial nerves may be present, though not usual; that of the sixth is most common, as it is most exposed to pressure on account of its course. These paralyses are apt to be slight and of varying intensity. The pupils are unequal and react slowly, or are stable. More or less diffuse spasms may occur. A most important symptom is optic neuritis, with atrophy. This is more frequent than in other forms of meningitis. In the chronic forms it is frequently associated with headache, vomiting, and mental dulness as the cardinal symptoms, thus simulating tumour; but after weeks or months such cases may end in recovery. The visual defect, instead of blindness, may be that of bitemporal hemianopsia, due to pressure from the dilated third ventricle upon the optic chiasma. Other symptoms are exophthalmos and cutaneous hyperæsthesia.

For the diagnosis, which at present in most cases must be extremely difficult, Quincke lays stress on the great variations in the intensity of the symptoms from day to day; at one time one symptom, at another time another, coming to the foreground. In the chronic cases the occurrence of remissions and intermissions must largely be relied upon to distinguish them from tumour, and when the rare focal symptoms (palsies, &c.) are present, the fact that instead of progressively deepening as with tumour, these symptoms have a temporary or varying existence.

As to the pathology of serous meningitis, the post-mortem results are for the most part limited to the accumulation in the ventricles of clear fluid which shows no material difference from the normal. It is pointed out by Quincke that while the effusion from cortical meningitis is almost always turbid, and therefore more or less rich in cellular elements and albumin, the reverse is the case in meningitis of the ventricles. The ventricles may be enormously distended, so that the convolutions may be flattened and the sulci appear obliterated. In the acute form the changes in the ependyma may be limited to hyperæmia; in the chronic form the only alteration may be some slight thickening and change in texture, described as smooth, velvety, granular or sodden. The pia mater may also be hyperæmic, and share somewhat in the process. In discussing the pathogenesis, Quincke likens the affection to acute angio-neurotic œdema of the skin (Quincke's disease), an analogy which renders intelligible the sudden development and variability of the symptoms observed.

In three cases fully described by Morton Prince[1] the symptoms were those embraced by the above clinical picture, but they were also most remarkable for their variety and variability. In two cases a post-mortem was obtained, and although the naked-eye appearances were those already given, it is noteworthy that in one case even

[1] Loc. cit.

a microscopical examination failed to reveal what are usually regarded as evidences of inflammation. Morton Prince, in view of these two autopsies and other findings, expresses the opinion that it seems questionable if the disease process is to be regarded as an inflammation. He considers that the pathology of the disease must still be regarded as obscure, and that it invites further investigation.

With regard to the above picture by Quincke, it is to be regretted that the terms " meningitis " and " serous " have been employed in conditions where they are not applicable. Firstly, because in the most typical cases there are no evidences of inflammation of the meninges ; and secondly, because there is no such thing as serum in the living body. That liquid is a product of the death (*i. e.* coagulation) of the blood. Then the suggested analogy of the condition to inflammation of other membranes—the pleura, pericardium, and synovial membranes—is hardly justifiable, for the distinctions between the serous membranes and lymph, and the arachnoid membrane and cerebro-spinal fluid, have already been pointed out (p. 98).[1]

Still, after allowing for these two objections, the above sketch of the hydrocephalus of adults appears to justify at least a consideration of the suspicion that the twenty-one cases I have collected may have been instances of this disease.

The Cerebral Symptoms in the Majority of the Twenty-one Cases.

It has already been pointed out that in no less than seventeen cases there were cerebral symptoms ; two cases are reported so inadequately that it is possible that slight nervous troubles may have been overlooked ; and in only one case (Emrys-Jones, XIX) have we a note as to the absence of all headache. In the seventeen cases the cerebral symptoms varied from headache to giddiness, severe

[1] Halliburton, ' Journal of Physiology,' vol. x, No. 4.

headache, heaviness, somnolence, drowsiness, vomiting, delirium, convulsions, and coma. Paretic symptoms were noted in four cases (IX, XVI, XVIII, XX). In eight cases the eyesight was affected, there being optic neuritis or atrophy. In one case there was proptosis. In one there was slight prominence. Enlargement of the thyroid was noted (XV). Vomiting was present in three cases (XV, XVII, XVIII). A striking point in which all the twenty-one cases appear to agree is in the absence of fever; but the rigidity of the neck and cervical pain, which Quincke says "may be prominent," do not appear to have been observed in any case. This, however, is easily understood if we may conclude that the effusion in all these twenty-one cases—judging from the escape of it through the nose—took place chiefly into the anterior fossa. Priestley Smith's second case (XVIII) very markedly resembles the picture of the acute form of serous meningitis passing into the chronic form. And Baxter's case (XV) is a striking example of "diffuse spasms" and neurotic symptoms. These neurotic symptoms appear to have been present in several cases; my own patient was thought by her medical attendant and her friends to be "rather hysterical;" and no doubt symptoms in several cases were put down to a neurasthenic constitution owing to their very variable character. This changeable character in the symptoms, the absence of any well-localised cerebral phenomena, the duration of the disease, and the arrest of the nasal flow for long periods, or even complete disappearance, all point towards the hypothesis of hydrocephalus and away from any suspicion of cerebral tumour. The post-mortem examinations in four of these cases give no positive evidence against the plausibility of this theory. The first case (V) is of value in a negative way, as it shows the absence of localised disease. In the second (VI) the results of the autopsy are a little confused, as the patient died from traumatic infection of the meninges. Paget's case (XII) also suffers from the pathological condition having been overlaid with

secondary infection; but in Baxter's (XV) the negative finding only bears out Quincke's view.

Finally, the fact that in most cases the head symptoms preceded the nasal flow, were always relieved by it, and generally recurred whenever it diminished, suggest that an internal hydrocephalus may be the diseased condition of which cerebro-spinal rhinorrhœa is one occasional consequence and symptom.

I do not wish to insist too strongly upon the similarity between the phenomena in the above twenty-one cases, and the symptoms grouped together by Quincke and others as indicative of the primary idiopathic hydrocephalus of adults. I believe the latter affection has still to justify its identity; and it is, of course, possible that—always excluding trauma and tumour—cerebro-spinal fluid may make its escape into the nose under different conditions. We have to bear in mind, also, and on the authority of Hughlings Jackson,[1] that "there are no symptoms known to be characteristic of meningitis only." The hypothesis is therefore only suggested as a provisional one. Even if proved untenable it may serve to direct attention to the frequent association of cerebro-spinal rhinorrhœa with cerebral and ocular conditions which have not been satisfactorily explained.

Route of Exit from the Cranial Cavity.

As to the method in which this flow makes its escape from the cranium we have very few facts to go upon, and any conclusions must largely be matters of conjecture. The condition is evidently not a congenital one. Still, many of the symptoms would be quite consonant with a small congenital meningocele situated in the region of the cribriform plate of the ethmoid, and rupturing into the nose under some exceptional pressure. This might

[1] 'Trans. Ophth. Soc.,' vol. i, 1881, p. 72.

explain the premonitory headache and the relief experienced on the establishment of the flow. But to such a theory it could be replied that there was no history of sudden preceding strain in any of the cases, and in those which were completed by an autopsy no trace of such a meningocele was to be discovered.

Another possible explanation is that it might be brought about by an anomalous development of a physiological communication between the subarachnoid space and the lymph channels of the nose. This anastomosis was first demonstrated by Schwalbe,[1] who succeeded in injecting the lymphatic vessels of the nasal mucosa from the subdural space. His experiments were made on animals, as were also those of Key and Retzius,[2] whose results tend to show that there is an open communication between the external air and the subarachnoid space. On injecting a coloured fluid, under feeble pressure, into the latter cavity the lymphatic spaces of the nasal mucous membrane were seen to be distended with the same fluid. The fluid not only accompanied the perineural sheaths, but also filled the lymphatic network which is altogether independent of the nerve sheaths. Indeed, Retzius claimed that on examining the cribriform plate he could observe fine canaliculi into which the meninges sent very thin prolongations, and quite independent of the canals for the nerves. Vertical sections of the injected olfactory mucosa showed that the coloured lymphatic ramifications traverse the epithelial layer to open on the very surface.

It is well to remember that this anastomosis has not been demonstrated in man, and to bear in mind the criticism of Zuckerkandl that we ought to be able to anatomically demonstrate the transition from the one system to the other, in order to meet the objection that the communication was made through the rupture of the pia mater under the pressure of the injection.

[1] "Der Arachnoidalraum ein Lymphraum, &c.," 'Centralb. f. d. med. Wissenschaften,' 1869, No. 30, s. 465.

[2] 'Stud. über d. Anat. d. Nervensyst., &c.,' Stockholm, 1875.

Flatau publishes in the 'Deut. med. Woch.,' October 30th, 1890,[1] an account of his experiments on the communication of the nasal lymph passages with the subarachnoid space. He states that Naunyn and Schreiber were able to inject warm salt solution into the subarachnoid space of the dog and make it come out at the nose, the phenomenon being accompanied by protrusion of the eye and chemosis. Flatau proves the correctness of these experiments by injection experiments of his own, but finds that, although injections into the subarachnoid space reached the nose, the injection of coloured fluid into the nose did not, however, lead to an entrance of the fluid into the arachnoid space. This he attributes to the barrier presented by the columnar epithelium. His experiments were made on rabbits and cats.

Nothnagel (p. 68) favours the view that the escape may be along the perineural sheaths, since in his case the sense of smell was lost and there was atrophy from pressure of the olfactory fibres. But anosmia does not appear to have been at all characteristic of the twenty-one tabulated cases.

The cerebro-spinal fluid may escape into other cavities besides the nasal fossæ without any obvious cause, such as fracture, to produce it.

The following observation of Vieusse[2] led him to the diagnosis that it is possible for an accidental opening to take place through the sphenoidal fissure, so placing in communication the capsule of Tenon and the cavity which contains the cerebro-spinal fluid, so that through this opening the liquid entered and made its exit from the orbital cavity, according to the position of the head.

A soldier presented himself for feebleness of vision in the left eye. The difference of aspect presented by the two eyes was striking. The right eye appeared normal, while the left globe seemed buried in an orbit with very prominent margins. On placing the finger on

[1] From Sajous' 'Annual of the Universal Medical Sciences,' vol. iv, 1891.

[2] 'Gazette Hebd. de Médecine et de Chirurgie,' tome xvi, 1879, No. 19, p. 299.

the globe of the eye and pressing lightly, one felt that the solid organ escaped and appeared to retreat into the back of the orbit, without giving rise to the least phenomenon of cerebral compression. Movement is normal and identical in both eyes; no deviation and no double vision. Hence it may be concluded that the fatty tissue in the left orbit has been absorbed, apparently by simple atrophy as in old age. Another point was that the eye changed its position according to the position of the head. When the head was bent forwards for a few seconds the eye became prominent, and the distended lids and congested conjunctivæ suggested a complete exophthalmos. The sight at the same time disappeared. On raising the head to the horizontal position, this state of affairs disappeared quickly, the eye resumed its normal primitive aspect and retreated into the orbit. The observation was repeated several times, and on no occasion was it possible to detect with the finger any throbbing or pulsations in the eyeball.

According to the patient's account he had never suffered from any head symptoms. He attributed the condition to his occupation as a carpenter, which caused movements of his head.

It is noteworthy that the return of fluid into the cavity of the skull did not induce any cerebral symptoms, such as occur in some of my cases when the flow ceased.

Finally, we have only the one post-mortem to appeal to to show that the fluid may escape through an "almost imperceptible" hole in the cribriform plate beside the crista galli. How this opening was caused I am unable to explain, nor why the flow should so frequently occur on the left side. It could not be attributed to a weak spot left by disproportionate growth during the course of development, for in several cases the flow commenced long after complete maturity. There might have been a congenital defect in the bone, the membranes covering it yielding after a time to continued pressure.

A simple solution of continuity in the base of the skull, arising in some unknown manner, may be the only explanation at present. It has been shown that this may occur into the external auditory meatus (p. 6), into the orbital cavity (p. 118), through the cribriform plate of the ethmoid (Case VI), or by way of the frontal (Case XIX) or other sinuses.

But in view of the frequent association of cerebral and ocular symptoms, and of the increase or recurrence of the former when the dropping ceases, I do not feel disposed to rest content with the suggestion that we have simply to do with a "leakage" through some accidental fissure.

Treatment.

As to the treatment I have, unfortunately, nothing to suggest. Until we know more about the pathology of the affection I should think it is desirable to refrain from any direct attempt to check the flow. The administration of powerful revulsives, the internal administration of large doses of ergot and other astringents, have proved utterly useless. Against the intra-nasal medication I would venture to particularly urge a warning. First of all, it is extremely doubtful if fluids sprayed or injected into the nose can reach the superior meatus where, presumably, the cerebro-spinal fluid makes it entry into the nose. Secondly, unless administered with strict aseptic precautions, the use of nose lotions certainly exposes the patient to the risk of infection of the fluid, and consequent meningo-encephalitis. And thirdly, if it is for the protection of the patient from ulterior consequences, the spraying of mild antiseptic solutions into the nose is quite uncalled for. Not only, as I have already said, does the nasal mucous membrane, in the absence of intra-nasal disease, provide for its own asepsis, but, as I have elsewhere pointed out,[1] no fluid sufficiently antiseptic to be of value could be used on such a sensitive surface as the Schneiderian membrane.

I think that while we may encourage the patient in the hope of the cessation of this troublesome dropping, we should clearly advise him against attempts to summarily check it, and, until our knowledge of the subject increases, to some extent explain to him, so far as he is

[1] "L'Antisepsie et les Médications Intra-nasales," 'Ann. des Mal. de l'Oreille, &c.,' January, 1895.

likely to understand the question, some of the peculiarities of his case.

It has been suggested that the advisability of trying lumbar puncture is well worth considering in my case.

Conclusion.

The record of one case in full, and the collecting together of these twenty others will, I trust, stimulate investigation of the subject. From the data given, the diagnosis of the condition can now present no difficulty, and I would suggest that all future cases should be kept under careful observation. When opportunity for a post-mortem does occur, needless to say that attention should be most carefully directed to the roof of the nose and the anterior fossa of the skull. It would not be sufficient to submit the floor of the skull to a naked-eye inspection; the fossa should be filled with coloured fluid and careful note made as to how it passes into the nose. The connection might possibly be traced *viâ* the orbit. Indeed, other factors will doubtless be brought to our knowledge which have escaped my observation or been absent in my case.

This publication will, I hope, have earned an excuse for its length by finally establishing a hitherto unrecognised pathological possibility. As in so many other affections at first recorded as "rare," it may be found that cerebro-spinal rhinorrhœa is only rare from not having been carefully looked for. Its recognition is not only of importance to the general physician, but in the present-day subdivision of disease it will as likely present itself to the neurologist and ophthalmologist as to those interested in diseases of the throat and nose. It may help to elucidate some hitherto obscure cases with cerebral symptoms, and certain unexplained instances of optic nerve atrophy. While its recognition is of the utmost importance, not the least interesting feature of the affection is the opportunity it affords for the examination of fresh, and

apparently quite normal, human cerebro-spinal fluid. Excepting the instance of Toison and Lenoble in 1891, my present case is apparently the only one where such an opportunity has presented itself. In view of the attention being given at present to lumbo-sacral puncture, the establishment of the exact physical, bacteriological, and chemical constitution of fresh, normal, human cerebro-spinal fluid is a point of considerable importance.

PART II.

OBSERVATIONS

ON THE

COMPOSITION AND FUNCTION

OF THE

CEREBRO-SPINAL FLUID IN THE HUMAN SUBJECT.

OBSERVATIONS ON THE COMPOSITION AND FUNCTION OF THE CEREBRO-SPINAL FLUID IN THE HUMAN SUBJECT.

Characters of the Fluid.

In the preceding pages the general characteristics and chemical properties of the cerebro-spinal fluid have been sufficiently dwelt upon. A complete analysis of the liquid will be found on page 17; its chemical composition is considered on page 86; the differences between lymph and cerebro-spinal fluid are indicated on page 98; and a table of chemical tests for the detection of cerebro-spinal fluid is given on page 104.

On page 20 attention has been directed to the sterile condition of the fluid, even after traversing the nose.

It has been pointed out (page 18) that the amount secreted may be over half a litre per day.

Comparison of the Morning and Evening Fluid.

While studying the literature of this subject I came across an interesting paper by Cavazzani.[1] He carried out a series of experiments on dogs in order to determine if the chemical constitution of the cerebro-spinal fluid remained the same after activity of the organism and after repose. He therefore killed four dogs at six in the morning, and

[1] "Sul Liquido Cerebro-spinale," 'La Riforma Medica,' anno viii, 1892, vol. ii, p. 591.

four others at six in the evening; in all particulars the two sets of dogs were as alike as possible, and killed in the same way. The small quantity of fluid obtainable (1 to 4 grammes) limited the study to the reaction and the amount of residual solids. The result was that the fluid collected in the morning was more alkaline than that in the evening; on an average the alkalinity was twice as much. Also, the morning fluid left a greater solid residue than that of the evening. Cavazzani suggests that this greater increase of solid residue and alkalinity is related to the activity of the nervous system, in view of the fact that between the morning and evening observations there was no other difference than the inertia of the nervous system. He does not think that the question of muscular repose need be taken into account, because the dogs were kept in a very small yard, and their muscular activity amounted to very little.

From these observations he concludes that his results constitute a demonstration of some value in favour of Obersteiner's theory of sleep. According to this the phenomenon of sleep is due to the accumulation of reducing substances in the brain. The greater quantity of solid residue met with in the morning cerebro-spinal fluid is, therefore, according to Cavazzani, due to the gradual elimination during the night of the substances which have accumulated in the tissues of the nervous centres during the activity of their waking hours.

He obtained corresponding results in the case of a man with traumatic fistula of the frontal bone.

In view of these observations, I thought that my patient's case presented an excellent opportunity for repeating them in the human subject. The fluid was therefore collected by the patient herself on several days, and forwarded to Professor Halliburton in two bottles, one containing the fluid collected the first thing in the morning, and the other the fluid collected the last thing in the evening.

The qualitative examination of the fluid collected on

several mornings gave the same results as that of specimens collected the last thing in the evening. Both were distinctly alkaline, but no estimation of the relative alkalinity was made. The following table gives in percentages the results of the qualitative analyses :

	Morning fluid.	Evening fluid.
Water	99·004	99·027
Solids	0·996	0·973
Organic solids . . .	0·118	0·100
Inorganic solids . .	0·878	0·873

The evening fluid is thus slightly poorer in both classes of constituents than that of the morning ; the difference is chiefly due to an alteration in the organic solids. This is just what we should expect, as the decreased capillary pressure during sleep would lessen the rate of exudation of water. Without committing ourselves to any theory on nervous activity or sleep, it will be seen that our experiments confirm those of Cavazzani.

Intra-vascular Injection of the Cerebro-spinal Fluid.

For some time Professor Halliburton, in conjunction with Dr. Mott, F.R.S., has been engaged in examining the results of injecting into animals cerebro-spinal fluid removed from cases of brain atrophy, especially from cases of general paralysis of the insane. This fluid contains a toxic substance, choline, doubtless derived from the disintegration of lecithin in the brain. Injection of such fluid into the jugular vein of animals (dogs, cats, rabbits), anæsthetised with ether, causes a marked lowering of arterial blood pressure, which is partly cardiac in origin, but principally due to the local action of the poison on the neuro-muscular apparatus of the peripheral vessels, especially in the splanchnic area.[1]

Professor Halliburton was good enough to make simi-

[1] 'Physiol. Soc. Proc.,' Feb., 1897, and Feb., 1898 ('Journ. of Physiol.,' vols. xxi and xxii).

lar experiments with the fluid obtained from my patient. Quantities varying from 7 to 10 c.c. were injected into the circulation in dogs, but with entirely negative results. Such a quantity in the case of fluid from a general paralytic would be quite sufficient to cause a marked fall of arterial pressure.

Similar negative results, both as regards blood pressure and respiration, were obtained with other specimens of normal cerebro-spinal fluid removed from other animals, or from cases of meningocele and hydrocephalus in children. In all such cases, also, choline was searched for chemically, but with negative results.

The Influence of Straining and Posture on the Flow and Composition of the Fluid.

In a monograph on the cerebral circulation[1] Leonard Hill has put forward the view that the rate of secretion of the cerebro-spinal fluid, when the cranio-vertebral cavity is opened, depends directly on the difference between the pressure in the cerebral capillaries and that of the atmosphere. He has also shown that cerebral capillary pressure varies directly and absolutely with vena cava pressure. Thus the cerebral capillary pressure can be raised with great ease by any agency which causes a rise of pressure in the vena cava or cerebral veins. On the other hand, cerebral capillary pressure varies directly, but only proportionately, with aortic pressure, for between the aorta and the capillaries there lies the peripheral resistance.

It follows from the above that the easiest methods of raising the cerebral capillary pressure in man are—

(*a*) By compression of the abdomen.

(*b*) By the assumption of the horizontal posture. In this position, however, the rise of venous pres-

[1] 'The Physiology and Pathology of the Cerebral Circulation,' by Leonard Hill. London: Messrs. Churchill, 1896.

sure may be compensated by the fall of arterial pressure, which normally occurs when the body is at rest. This is, no doubt, the case during sleep.

(*c*) By straining or forced expiratory effort, with the glottis closed.

By all these methods the vena cava pressure is considerably raised; and by the last method the venous inlets into the thorax may be completely blocked, and the pressure in the cerebral capillaries raised to something like aortic pressure.

It is true that, by such a forced expiratory effort, the aortic pressure is lowered. Nevertheless, the total effect on capillary pressure is a very great rise, for a fall of aortic pressure of 25 mm. of mercury produces a fall in cerebral capillary pressure of less than 5 mm. of mercury, while a rise of vena cava pressure of 25 mm. of mercury produces a rise of cerebral capillary pressure of 25 mm. Hg.

My patient's case presented a unique opportunity for testing the correctness of these views on the living human subject. I therefore invited Dr. Leonard Hill to suggest any observations he might wish made, and I had the pleasure of assisting him in a series of experiments which entirely confirm his views.

As will be seen from the following figures, the flow of cerebro-spinal fluid is accelerated by all those circumstances which raise the cerebral capillary pressure. The increase in flow is, moreover, accompanied by a decrease in the percentage of solid matter.

As in all the other observations, the chemical investigation of the fluid was performed by Professor Halliburton.

We first of all made the following observations :—

1. Patient sitting quietly without straining. In five minutes 23 minims (1·357 c.c.) were collected.

2. Patient sitting and straining. In five minutes 35 minims (1·965 c.c.) were collected.

3. Patient sitting quietly. In five successive minutes

the amounts collected were respectivcly 8, 7, 5, 5, 5 drops. The total mcasured 19 minims (1·021 c.c.).

4. Subsequent to this, five minutes were occupied by the patient in straining, and the amounts collected in consecutivc minutes were 12, 10, 8, 9, and 10 drops respectively. The total measured 33 minims (1·947 c.c.).

5. Patient lying down and not straining. The drops fell as follows in five consecutive minutes 9, 6, 5, 5, and 5, and the total mcasured 27 minims (1·593 c.c.). Here the arterial pressure was probably not decreased owing to mental excitement, while the cerebral venous pressure was increased.

6. Patient lying flat on the stomach and head hanging over the end of a sofa. The drops fell as follows in five consecutive minutes—8, 7, 6, 7, and 7. The total measured 28 minims (1·652 c.c.).

7. Finally, after the last experiment, the following was collected during quiet dropping, while the patient was sitting with the head forward. Thc drops fell as follows: 5, 4, 4, 4, and 4, in five succcssive minutes; and the total measured 15 minims (0·885 c.c.).

The following is thc report on the chemical examination of the fluids:—

So far as the small quantities available admit of analysis, the fluids are the same qualitatively. The liquid which cscaped passively, and that which passed under straining, both contained a small quantity of organic and inorganic solids. Among the organic substances present are the rcducing substance and a trace of proteid. Judged by the amount of prccipitate produced by alcohol in equal amounts of the two fluids, the proteid is less abundant in the fluid passed during straining, but the amount is too small to weigh.

Determination of the total solids gave the following results, expressed in percentages:—

A. The fluid passed passively, 1·1 per cent.

B. The fluid passed during straining, 0·43 per cent.

Even the higher of these numbers is less than in cases

of cerebro-spinal fluid from meningocele and hydrocephalus (W. D. Halliburton).[1]

In addition to the foregoing, two specimens were collected at home by the patient herself. Analysis of these gave the following results :—

A. Fluid collected while patient was sitting upright quietly. The percentage of solids was 1·11.

B. Fluid collected while she was lying down. The percentage of solids was 1·03.

The effect of the horizontal posture is in the same direction, though not so marked as the effect of straining. This is what was to be expected, for the horizontal posture would not raise the venous, and thus the cerebral capillary pressure so much as powerful expiratory efforts would. Moreover, the arterial pressure falls during quiet rest in the recumbent posture, as Dr. Leonard Hill has determined.[2]

In order to note the effects of straining on the retinal circulation, Mr. Vernon Cargill was asked to examine the patient, and he kindly reported as follows :—"I noticed that when a straining effort was made, a decided but transitory narrowing of the retinal arteries on and adjacent to the disc occurred, and also a marked pulsation in the trunks of the retinal veins."

The transitory narrowing of the arteries points to the temporary lowering of the aortic pressure, while the pulsation of the veins is a sign of the capillary engorgement due to venous congestion.

Experiments made with Abdominal Compression.

These experiments were made in order to complete and confirm those just recorded. The patient was seated, and I compressed the abdomen as firmly and evenly as possible by spreading both hands over the front of it. The number of drops per minute were counted as before, and periods of compression lasting five minutes were alter-

[1] 'Journ. of Physiol.,' vol. x, p. 232.

[2] 'Phys. Soc. Proc.,' January 15th, 1898.

nated with periods of the same duration, during which the patient was sitting quietly.

The following table gives the results succinctly :—

Condition of patient.	Drops in successive minutes.	Total collected.	
		Minims.	c.c.
A. Abdomen compressed ...	11, 9, 8, 7, 5	27	1·593
B. Sitting quietly.....	4, 5, 3, 4, 4	14	0·826
C. Abdomen compressed ...	11, 8, 8, 6, 6	24	1·416
D. Sitting quietly	6, 7, 8, 6, 6	Measurement omitted.	

The fluids from experiments "A" and "C" were mixed together; also those from experiments "B" and "D." Determination of the total solids gave the following results :—

"A" and "C." Fluid collected during abdominal compression. Percentage of solids, 0·68.

"B" and "D." Fluid collected while the patient was sitting upright quietly. Percentage of solids, 1·14.

The experiments confirm those recorded in the preceding section. Abdominal compression raises the vena cava pressure, and so leads to increased cerebral capillary pressure, and in this way to increase in the volume of the cerebro-spinal fluid secreted. Increase of volume, as before, is accompanied with fall in the percentage of solids present.

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